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Proceedings of the Twenty-Second Annual Meeting of the American Association of Economic Entomologists

(Continued from the February issue)

Morning Session, Wednesday, December 29, 1909

The meeting was called to order by President Britton at 10.15 a. m.

PRESIDENT BRITTON: The first paper to be presented is by Mr. E. D. Sanderson, Durham, N. H., on "The Relation of Temperature to the Growth of Insects."

THE RELATION OF TEMPERATURE TO THE GROWTH OF INSECTS

By E. DWIGHT SANDERSON, *Durham, N. H.*

At the Chicago meeting of this association in 1907 the writer showed (24a) that upon purely theoretical grounds there could be no uniform accumulation of temperature or "thermal constant" for the various stages of insect growth, but that the relation of temperature to growth phenomena was probably different for each species and might be expressed by a curve, the abscissas of which represent degrees of temperature and the ordinates represent the time factor. The importance of considering the so-called law of the velocity of chemical reaction as influenced by temperature was pointed out and it was shown that the velocity of reaction varies at different temperatures. It was shown that both the so-called thermal constant and coefficient of velocity increase as the temperature is lowered from the optimum of the

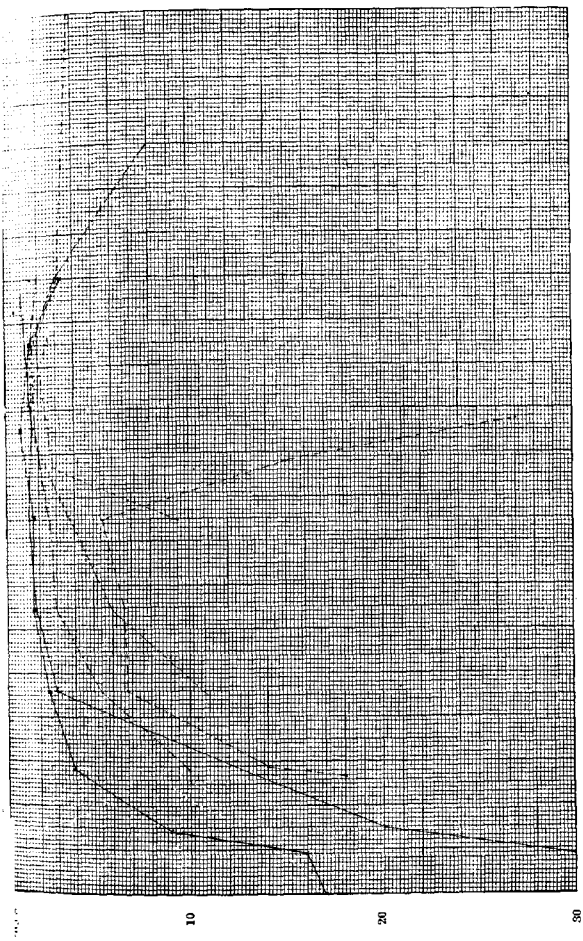

Fig. 6. Germination of seeds at different temperatures according to DeCandolle, as given by Abbe, original. ——— *Lepidium sativum*; ——— x *Sinapsis alba*; ——— ——— *Zea mays*; ——— *Lactuca sativa*; ——— ——— ——— *Triticum repens*; ——— *Melon, cantalupe*.

of growth, if there be no "thermal constant" (*physiological constant* of Merriam) as far as a mere accumulation of temperatures is concerned, and if the velocity of reaction varies according to the range of temperatures; what then is the relation of temperature to the phenomena of insect growth and how may we express it in numerical terms?

To answer this question we must first have facts and then seek an explanation. During the past year we have reared different stages of several insects at fairly constant temperatures. Large numbers of most of the insects have been employed so as to secure fairly accurate averages. Ordinary bacteriological incubators were used for temperatures of 80° and 90°F. An un-iced refrigerator maintained a fairly constant temperature of about 65°F. in winter and 70°F. in

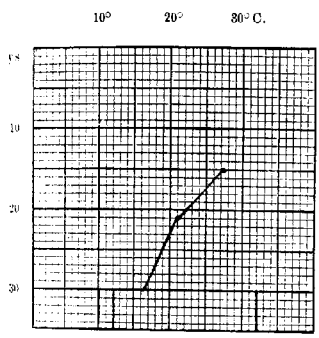

Fig. 8. *Euproctis chrysorrhœa.*

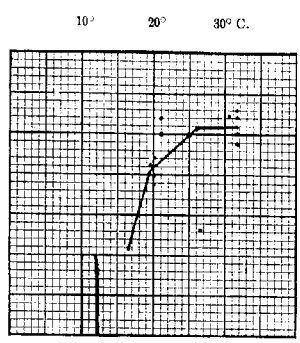

Fig. 9. *Samia cecropia*, original.

Relation of temperature to the period of incubation of eggs.

summer. A constant temperature apparatus in which the cold from an ice chamber was balanced by the heat from a gas jet and controlled by an electric thermostat gave close to 60°F. and an ordinary refrigerator was iced so as to maintain approximately 50°F. The details of the work involving a large amount of labor were carried on by Mr. and Mrs. C. F. Jackson, to whom the writer is greatly indebted for the results.

Only an outline of the results will now be given, the details of the experiments being published later. The pupæ of *Malacosoma americana*, figure 7, were transferred to six different temperatures upon pupation and the emergence of the moths noted. At from 16° to 32° C. they emerged in the time shown by the curve, but at 10° and 12° C. all died. It will be noted that from 20° to 30°C. the coefficient of velocity is practically 2, while below 20° it increases very rapidly.

This will be seen to be generally true for the insects cited, as it has been found for most animals and plants so far studied which live at normal temperatures.[1]

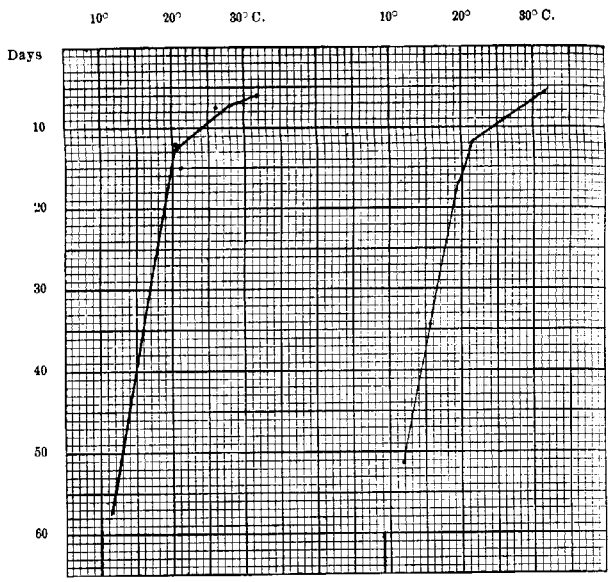

Fig. 10. Relation of temperature to egg and pupal periods of *Tenebrio molitor* (original).

The eggs of the brown-tail moth, *Euproctis chrysorrhœa*, were placed at the same temperatures and their curve is shown in figure 8. They also failed to hatch at 10° and 12°C. and also at 32°C., showing that the latter is above the optimum for a constant temperature. In this

[1] The coefficient or index of the velocity or rate of growth or activity is usually expressed in terms of the difference between two temperatures 10°C. apart, and is expressed by the formula $\frac{\text{Rate at } T_n + 10}{\text{Rate at } T_n}$, in which the rate is the rate of activity or time of growth at the given temperature, T_n. To determine the coefficient between any given temperatures with given rates we have the formula $\frac{\text{Rate at } T_n}{\text{Rate at } T_n + X} \times \frac{10}{X}$, in which X is the difference in temperature between the two points. Thus if the pupa transforms in twenty days at 20°C. and in ten days at 30°C. the coefficient of velocity is $\frac{20}{10} \times \frac{10}{10} = 2$.

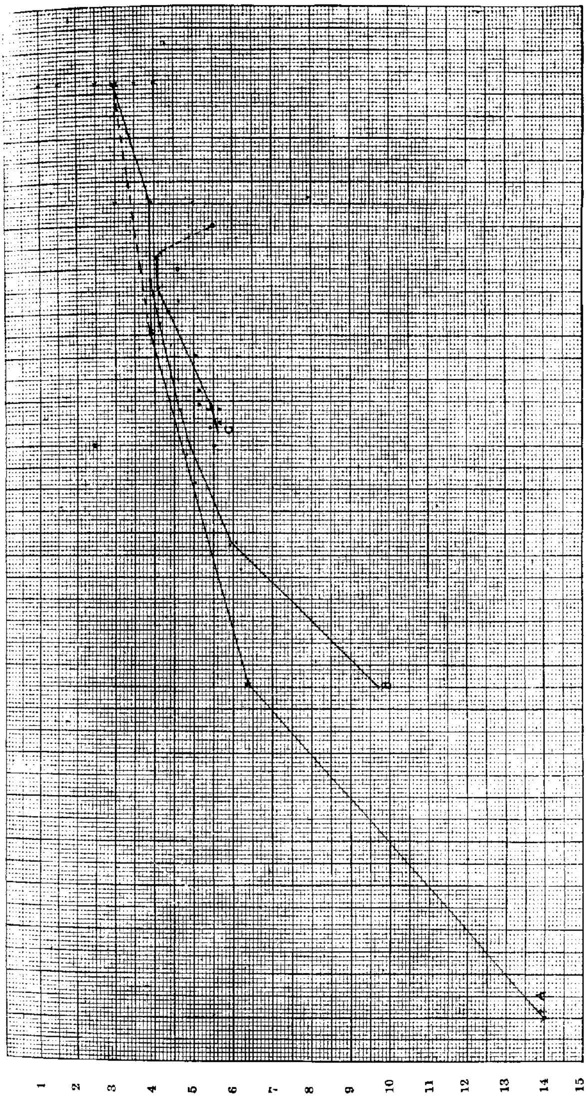

Fig. 11. Relation of temperature to incubation of eggs of *Leptinotarsa decemlineata*. A, from author's data; B, from Girault (Ohio, 1908); C, from Girault and Rosenfeld, Georgia, 1906 (original).

case the coefficient of velocity is greater, being about 3 between 16 and 21°C. and about 2.2 between 21 and 26°C.

The eggs of *Samia cecropia* also failed to hatch at the low temperatures, but hatched at 32°C. though the latter temperature is seen to be above the optimum from the fact that the time did not decrease above 26°C. See figure 9.

The eggs and pupæ of *Tenebrio molitor* were handled in the same manner. The larvæ have also been used, but as yet we have no definite results, owing to difficulty in rearing them under the artificial conditions. The eggs and pupæ both failed to transform at 9° or 10°C. though they did so at 12°C., showing that the minimum temperature for growth is slightly below the latter temperature. The curves, figure 10, for the egg and pupa are of interest as they are based on a large number of individuals and show a similarity which is to be observed in other species, indicating that the eggs and pupæ, where they exist under similar conditions are similarly affected by temperature, while the active larvæ is much more quickly influenced by changes of temperature.

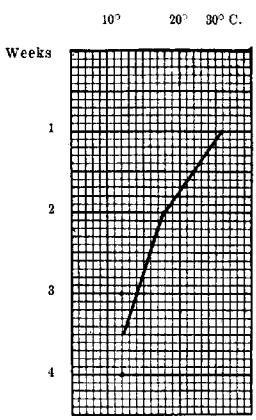

Fig. 12. Relation of temperature to life cycle of *Culex pipiens* according to data of Kerschbaumer (original).

The eggs of *Leptinotarsa decemlineata* were similarly studied and the results are shown in figure 11. The time at 12°C. is questioned because of inaccuracy in the records. The major portion of the curve is of interest when compared with the work of Girault and Rosenfeld in which the time of incubation was determined in Georgia and Ohio under natural conditions, using the average mean daily temperature for the period. It will be noted that the curves between 23.5° and 28°C. are very similar, but that in Georgia the time is prolonged at 29°C., while in our incubators it continued to shorten up to 32.5°C. This may possibly be due to dryness of the atmosphere in Georgia at the time of the observations, of which we have no records. It is known that lack of moisture at high temperatures very quickly lowers the optimum for development. In our own work we have not used apparatus by which we could maintain a constant degree of moisture, but vessels of water have been placed in the incubators and fairly

mal conditions, record of which we have been maintained. In exact work to determine the effect of temperature the moisture conditions should be constant, as with many species the moisture influence is as much or more important than that of temperature in determining the optimum for development.

Similar observations on the time of hatching of the eggs of *Malacosoma americana*, the time of emergence of the caterpillars of the brown-tail moth from their winter nests, the hatching of eggs of the gypsy moth, and the pupal stage of *Samia cecropia*, *Papilio asterias* and *Epargyreus tityrus*, have been or are now being made, but cannot be summarized at present.

Other data is at hand, however, showing the same facts. Thus Kerschbaumer (15) has given data from which the curve for the life cycle of *Culex pipiens* as influenced by temperature has been plotted (figure 12), and Regener (21) and Ratzeburg (20) have shown the same for the different stages of *Dendrolimus pini*, shown in figure 13. One of the most careful studies of the relation of both temperature and moisture to the development of an insect is a recent one of Hennings (9) with *Tomicus typographus* Linn. Hennings reared all stages and secured the complete life cycle of this species at four different temperatures with 55% and 96% moisture. Figure 14 shows the curves plotted from his data and shows graphically the effect of moisture as related to temperature for the species. Hennings points out that no thermal constant for the development of the species, which several European students of forest insects had endeavored to determine, could possibly exist as at 24°C. there would be an accumulation of 624° when at 14°C. it would amount to 1400.°

Other activities of insect life as related to temperature show similar curves, one

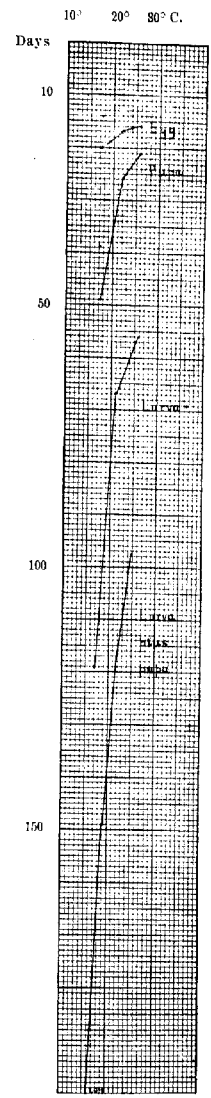

Fig. 13. Relation of temperature to development of *Dendrolimus pini*, from data quoted by Bachmetjew; egg, pupa and larva from Regener, 1865; larva plus pupa from Ratzeburg, 1839 (original.)

or two of which have been plotted by Bachmetjew (2a). Thus the rate of pulsation of the heart of the silk worm has been given by Tichomirow (26) figure 15, and the food eaten by the larvæ of *Dendrolimus pini* by Regener (21), figure 16, all indicating the same general relation of temperature to insect activity.

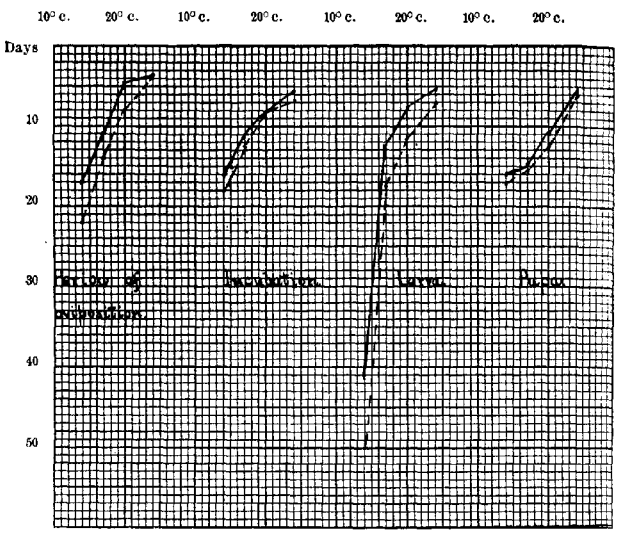

Fig. 14. Relation of temperature to different stages of *Tomicus typographus* Linn; solid line represents 55 per cent and dash line 96 per cent moisture: as given by Hennings (1907), original.

Recent records of some of our own workers have also given data from which we have been able to plot curves which are approximately correct, though the diverse conditions and lack of exact temperature records, make them only approximate. Thus we have taken the weather records for Paris, Texas, for 1904 and have determined the average temperatures for the egg, larva and pupa stages of the Boll Worm as given by Quaintance and Brues, which are shown in figures 17 and 18. The excellent work of Jenne upon the life history of the Codling Moth in Arkansas has given us the best data concerning the egg stage of that insect, which we have plotted in figure 19.[1]

[1] Unfortunately no temperature records are available for Siloam Springs, Ark., where the work was done, but we have used the weather records of Fayetteville, which is but twenty-five miles east and has practically the same climate, so that the average temperature would be almost identical.

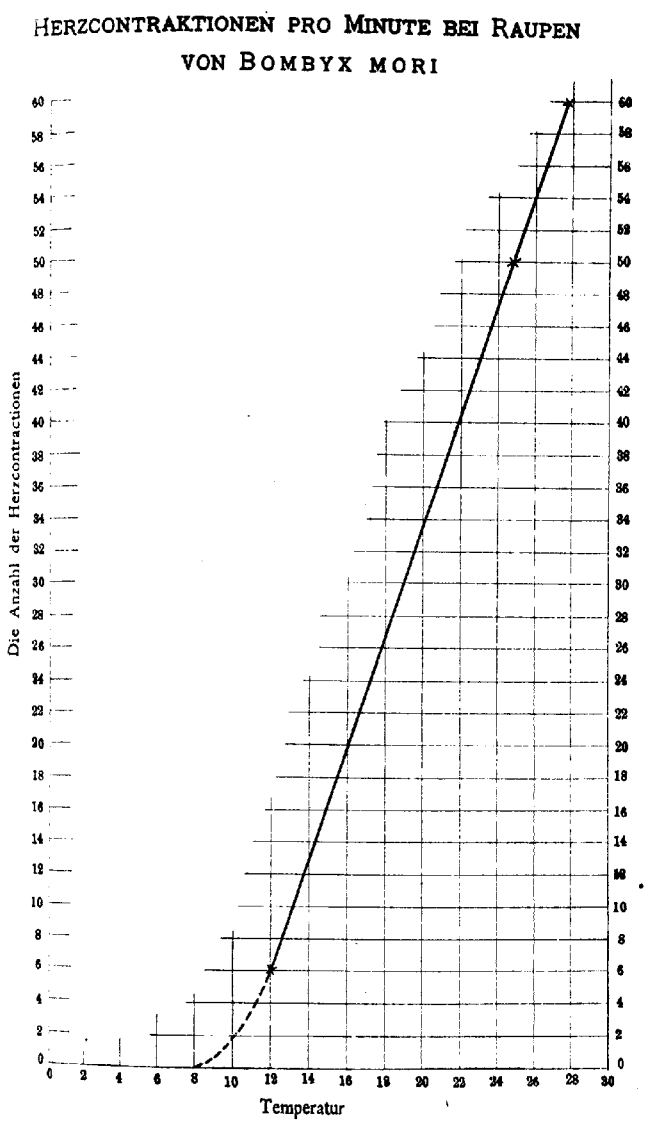

Fig. 15. Relation of temperature to the rate of heart contraction of larvæ of *Bombyx mori*, according to Tichomirow (26), from Bachmetjew.

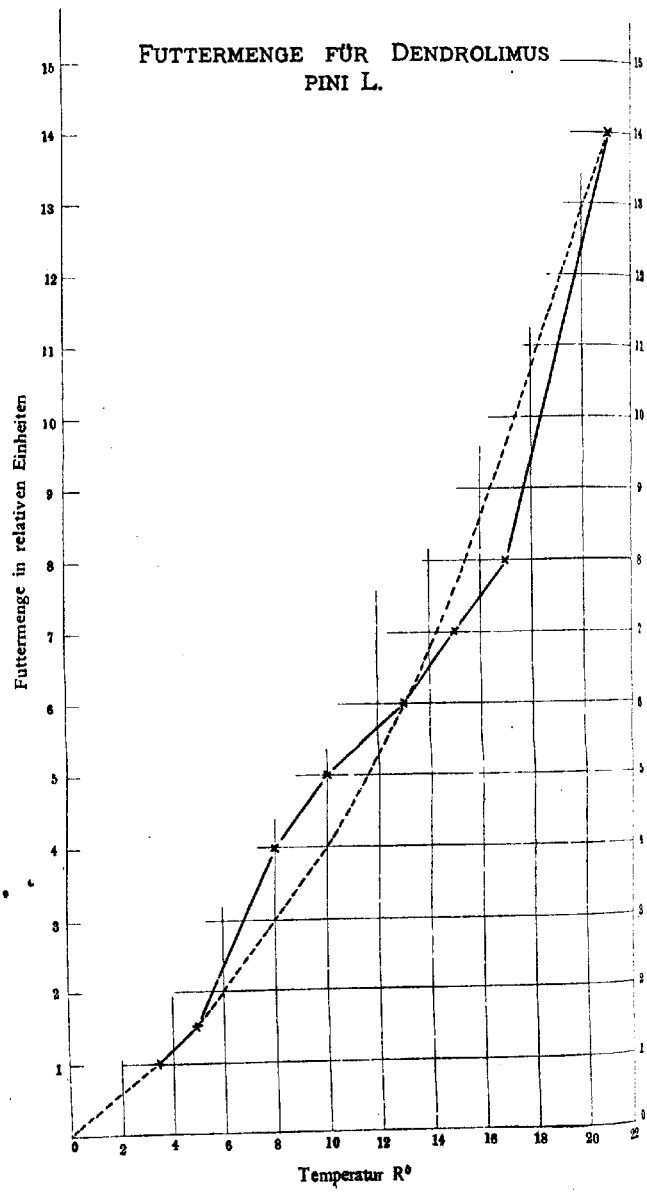

Fig. 16. Relation of temperature to the amount of food eaten by larva of *Dendrolimus pini*, according to Regener (21), from Bachmetjew.

The pupal stage has been similarly plotted from his data, figure 20, and with it are given the records of Melander and Jenne (16) in the Yakima Valley, Washington, in 1904, those of Gillette in Colorado in 1901 and our own for the last four seasons and for rearings made at constant temperatures. It is interesting to note the close approxima-

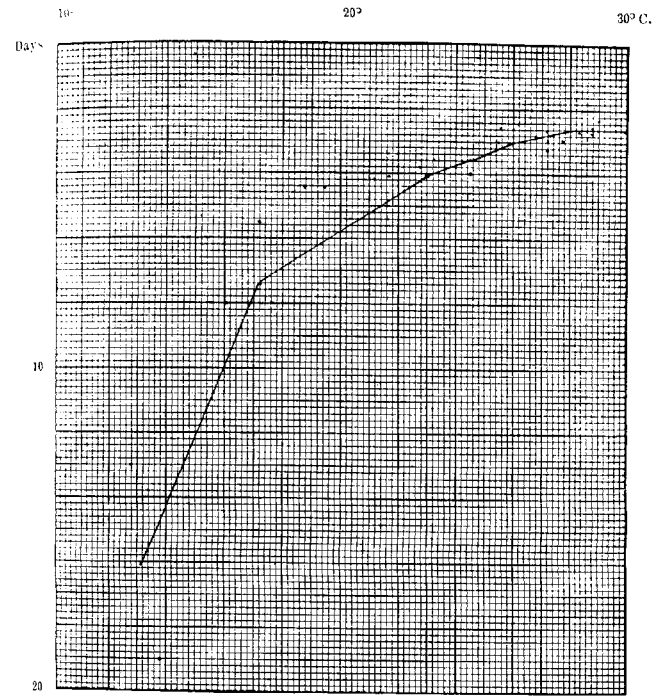

Fig. 17. Relation of temperature to incubation of eggs of *Heliothis obsoleta*, according to Quaintance and Girault (original).

tion to the curve of all this data from diverse sources. Later we hope to be able to make a more complete study of the relation of temperature to the codling moth. The subject is complicated with the pupæ of this insect by the fact that the spring pupæ may be derived from the two broods of the previous year, which may possibly be differently affected by temperature. The curve for the codling moth pupa also shows how quickly it is influenced by temperature, showing why it is that so much longer is required for the pupa in early spring and how

the accumulated temperature decreases accordingly with the advancement of the season. The curve also indicates that but little development of the codling moth takes place below 55°F. and that it is very slow under 60°F.

This data is sufficient to indicate the general relation of temperature to the rate of growth, or activity.

A few days after the presentation of my last paper upon this subject I received the second part of Bachmetjew's Experimentelle Entomologische Studien, published in 1907 (2a). This is an encyclopaedic

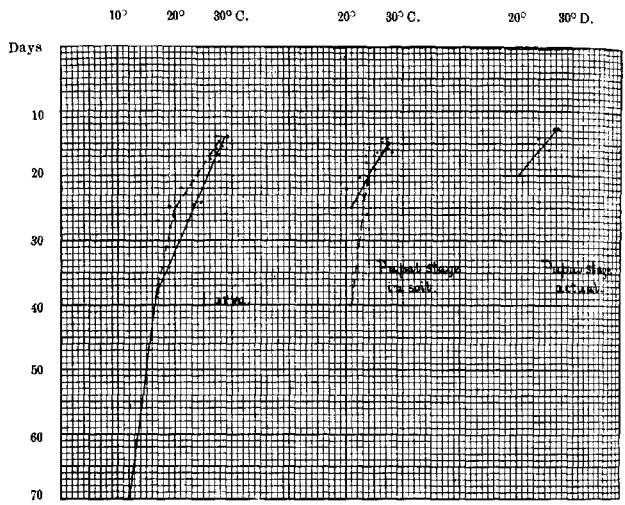

Fig. 18. Relation of temperature to larval and pupal stages of *Heliothis obsoleta*, according to Quaintance and Girault (original).

work dealing with all entomological phenomena in their chemical and physical aspects. It is a monumental work which will serve as a guidebook for entomological students of these subjects in the future. In the first part of this work (2) Bachmetjew dealt with the relation of low temperatures to insect life, but in the second part he discusses the whole range of temperature as related to insect activity and brings out the relation of the temperature and time factors with great clearness. His views are well summarized in figure 21, briefly as follows: (2a, p. 859.) For every species there is a certain range of temperature, K to W, in which it is normally active. At a certain point its growth or activity is most rapid, an increase or decrease of tempera-

are from this point alike resulting in retarding the growth or activity. This point is the *optimum* (Z.). When the upper temperature limit of activity is passed, at W, heat-rigor ensues. If the heat be increased to a point A, death will result in a short time. This point, A, is known

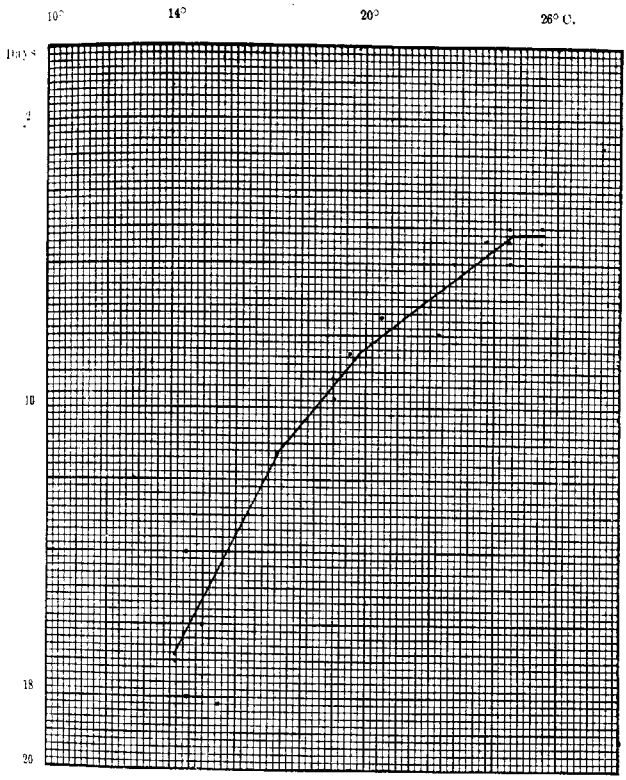

Fig. 19. Relation of temperature to the incubation of eggs of *Carpocapsa pomonella* in Arkansas, according to Jenne, 1908 (original).

as the maximum. But a temperature above A may be endured for a short time before death, but if the insect is brought to a temperature of B death is practically instantaneous due to the coagulation of certain proteids of the protoplasm. Although heat-rigor occurs at any point above W, the effect of it is due to the length of time of the exposure. Thus a varying length of exposure, according to the amount

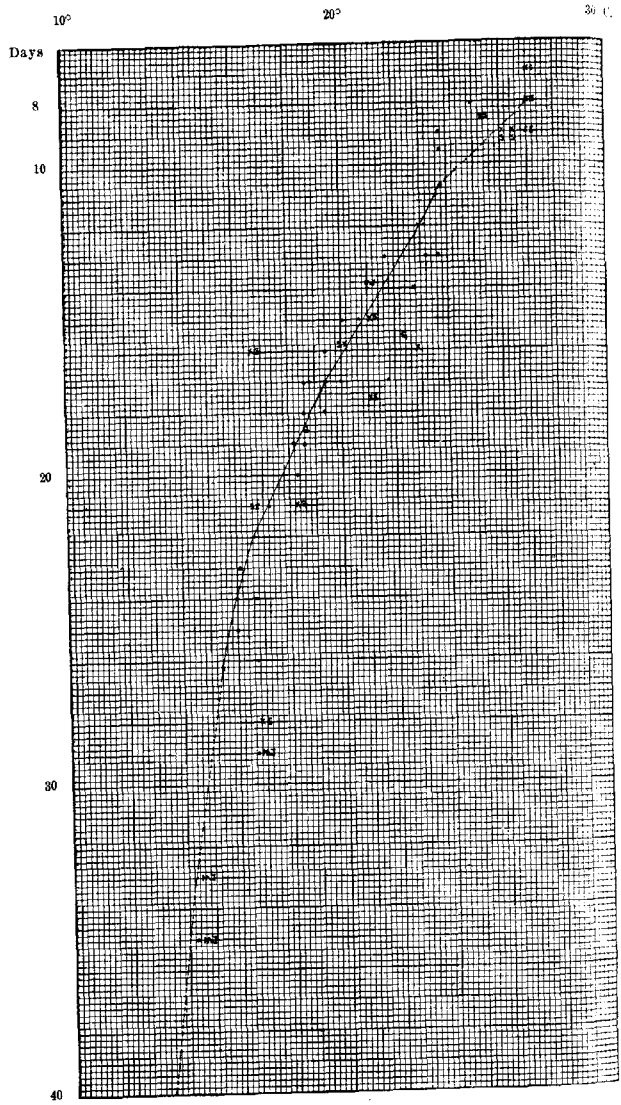

Fig. 20. Relation of temperature to the time of the pupal stage of *Carpocapsa pomonella*:— . . . according to Jenne, Arkansas, 1908; G— according to Gillette, Colorado, 1901; MJ—according to Melander and Jenn Washington, 1904; xs—from author's data, New Hampshire, 1906–0 (original).

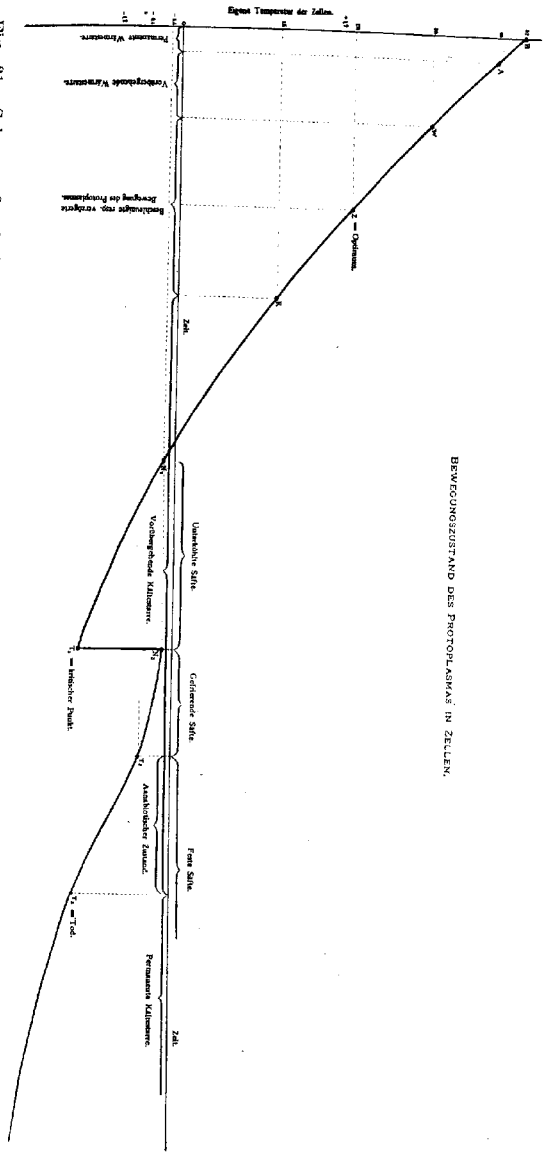

Fig. 21. Scheme of relation of temperature to the movement of protoplasm in the cells according to Backmeyer, from

of temperature, as long as the temperature remains below the maximum A, will not kill the organism if it be returned to normal temperatures, while it will die if maintained at a constant temperature above W. Metabolism does not necessarily cease during heat-rigor at temperatures above W, but is greatly retarded.

If the temperature is lowered, then at a point K, cold-rigor sets in and activity ceases. If it be cooled below freezing to a point T_1, termed the "critical point," the internal heat of the insect rebounds to a point N_2. But if the body temperature again falls below the critical point, as at T_3, then death ensues. If after the critical point has been reached and the rebound occurs, the insect be removed to normal temperatures, it will usually revive, depending upon the length of time it has been under-cooled. As in heat-rigor, metabolism does not cease at temperatures producing cold-rigor, though no activity is apparent, but below a point T_2, all metabolism ceases. Death at low temperatures is held to be due to molecular rearrangement and mechanical injury, whereas death at high temperature is due to chemical changes in the proteids. The relation of both excessive heat and excessive cold is therefore seen to depend upon the time involved and the rapidity with which the organism is cooled or heated and with which it is subsequently brought back to normal temperatures.

This, very briefly, is my understanding of Bachmetjew's views which he supports by the citation of the whole literature bearing on the subject.

In his Experimental Morphology Davenport brought out the same facts as regards both plants and animals, but uses a slightly different terminology. The point at which metabolism ceases at high temperatures is termed the maximum, and at which death is immediate the ultra-maximum, and likewise, the point at which metabolism ceases with low temperature is called the minimum, and the "critical point" of Bachmetjew upon the maintenance of which death ensues, is called the ultra-minimum. This term is preferable to that of "critical point," for both minimum, optimum, and maximum are critical points in the relation of temperature to the life of the organism, and the term has been so differently used by different groups of workers and by different sciences that it lacks definiteness. The temperature below which cold-rigor ensues is often termed the "minimum temperature for activity" or growth, or germination, but as the true minimum is somewhat below this, we may better term it the *point* of cold-rigor and the temperature at which heat-rigor commences the *point of heat-rigor*, the latter also being below the real maximum.

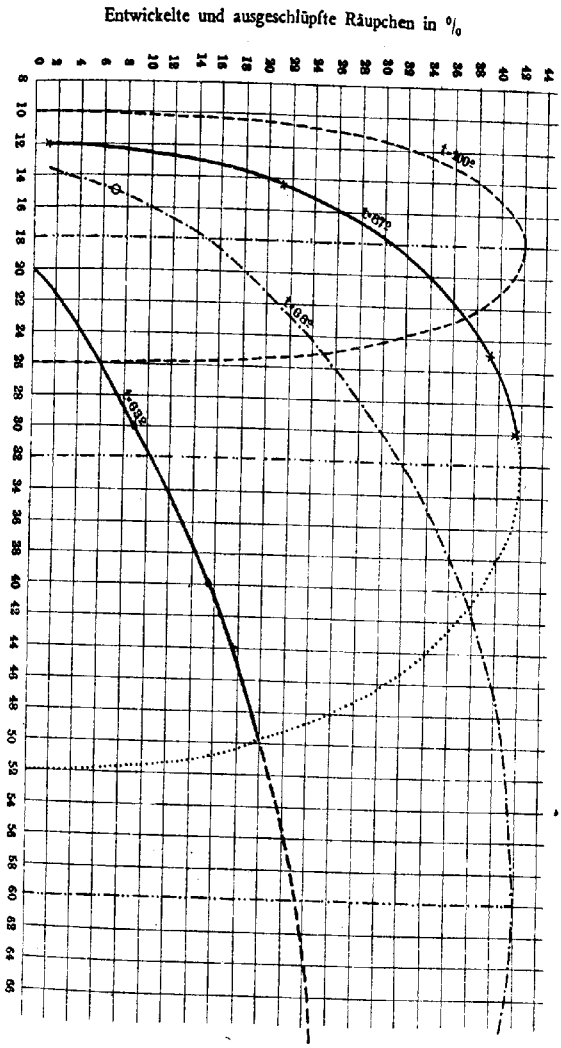

FIG. 22. The influence of temperature for varying length of time on the mortality of eggs of *Bombyx mori*, according to Bellati and Quajat (3), from Bachmetjew.

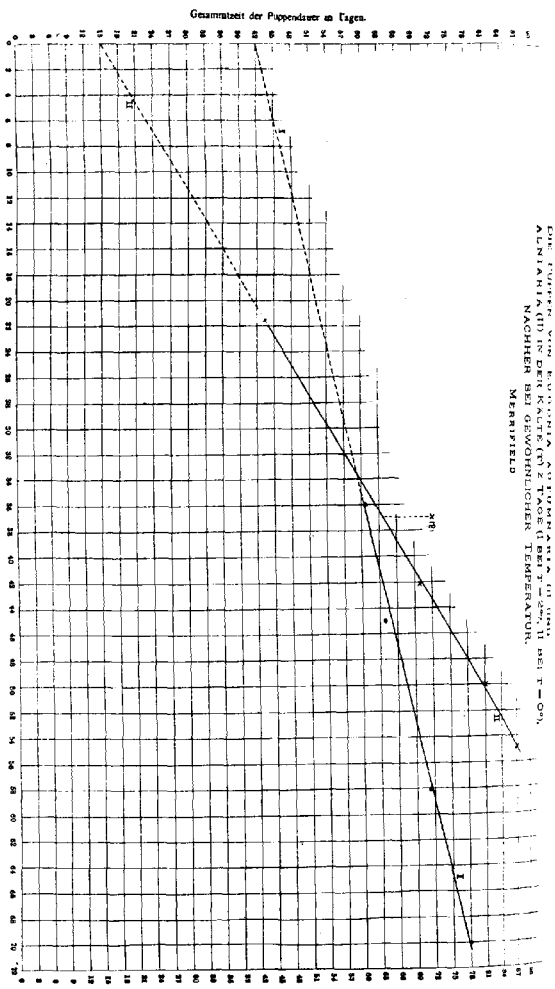

Fig. 23. Relation of temperature to the development of pupæ of *Ellopia autumnaria* and *E. almiaria*, according to Merrifield, from Bachmetjew.

The effect of short exposure to heat above the point of heat-rigor is well shown by the experiments of Bellati and Quajat (3) in which silk worm eggs were maintained at constant high temperatures for a few seconds and the subsequent mortality then noted. The curves in figure 22 show that the higher the temperature the shorter the time eggs may be exposed to it, and although the eggs may be exposed to a lower temperature for a much longer time, if they remain at any temperature above that of heat-rigor, they will die.

The fact that metabolism continues at low temperatures has been shown by Merrifield (18) in his experiments with pupæ of *Eugonia autumnaria* and *alniaria* exposed to 2° and 0° C. respectively for varying lengths of time and then developed at room temperature. As shown in figure 23, the pupæ of *E. autumnaria* at 2° C. as the time for emergence after they were brought to normal

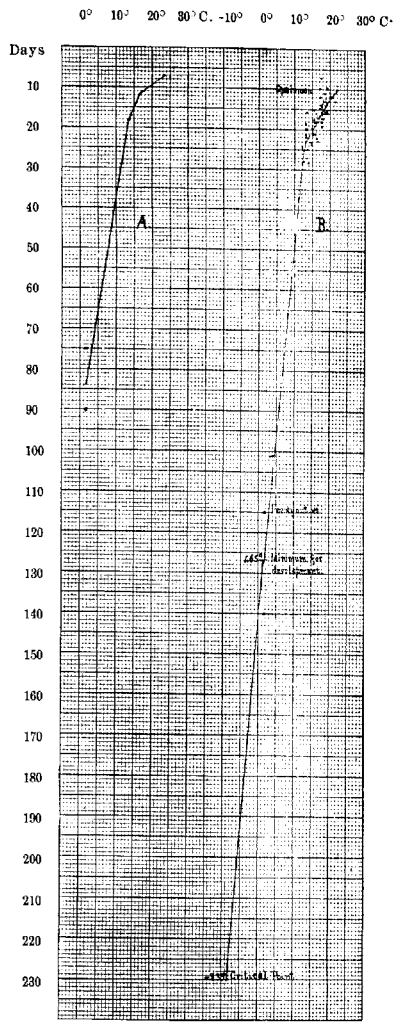

Fig. 24. Relation of temperature to the development of *Lyaiphlebus tritici*, A, and *Toxoptera graminum*, B, according to Hunter and Glenn (original).

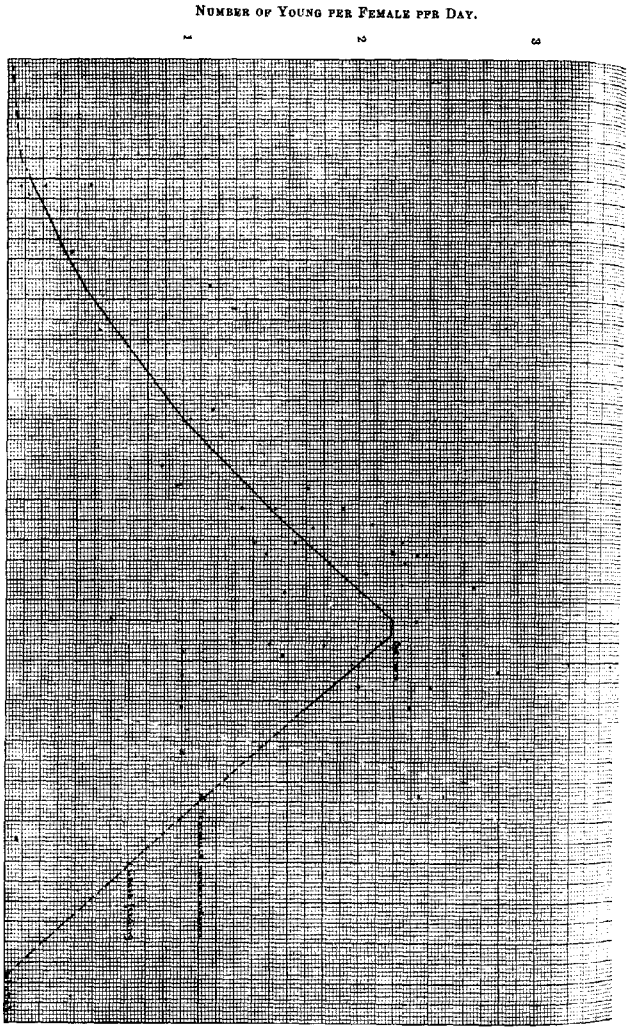

Fig. 25. Relation of temperature to the number of young borne per female per day of *Toxoptera graminum*, according to Hunter (original).

temperature was less the longer they were held at 2°C., while the pupae of *E. alniaria* showed no development at 0°C. and their subsequent development was retarded by it. Evidently the former species was slightly above, and the latter slightly below its respective minimum. It is known that short exposures to temperatures below the minimum retard the development of some species and hasten that of others, depending upon the species, the temperature and the time exposed.

The influence of low temperatures has also been nicely shown in the studies of Hunter and Glenn (11) on the Green Bug (*Toxoptera graminum*) and its parasite *Lysiphlebus tritici*. The rates of growth of these insects are shown in figures 24 and 25, which are plotted from the records given, showing that development may take place at a mean 1.65°C., while the point of cold-rigor is slightly higher for *Lysiphlebus*, which shows no activity below about 4° or 5°C., while the ultra-minimum or "critical point" of Bachmetjew, at which death occurs, is about —8.33°C. or 17°F. Similar phenomena are shown by the rate of reproduction of *Toxoptera* as plotted in figure 25, in which it is seen that reproduction may actually occur at a daily mean of —7.8°C. and that it is frequent at a daily mean of 0°C. This curve is of additional interest, however, because it gives the optimum of the species, about 20°C., from which the rate of reproduction gradually decreases, though it is known to occur at about 29°C. until the aphides cease feeding at 32°C. and death ensues at 37.5° to 40°C.

It is interesting to contrast these points of cold-rigor hovering around 0°C. with those of the Bollworm which is about 10°, as well as several others previously cited, and that of the Cattle Tick which is about 5°C. It is evident, then, that the point of cold-rigor and the minimum must be determined for each species, and for each phase of its growth. Dr. L. O. Howard (10) has given these points for several houshold pests and has shown how such a knowledge may have most practical value in the prevention of insect injury in cold storage. Similar data has been given by Duvel (6) for weevils affecting cowpeas. Recently a tobacco manufacturer has applied to us for aid in the destruction of a pest of stored tobacco, which we believe may possibly be accomplished by the use of low temperature.

From the above data it is evident that any accumulation of temperature to secure a thermal or physiological constant cannot be based on a mere addition where variable temperatures are involved, for it is evident that every degree has a different value in relation to the time factor. Thus as the mean temperature rises with the advance of the season both the time for the pupal stage and the total accumulated

temperature for the pupal stage of the codling moth decrease with the advancing season. Though a fairly constant "total effective temperature" for any given phase of an insect's life or activity may be secured for the summer months when there is a fairly constant mean temperature, such an accumulation will have no meaning in regard to the same phenomena in spring and fall when the temperatures are more variable. Thus in the total "effective temperature" in the hatching of the eggs of the cattle tick as given by Hunter and Hooker, eggs laid from September 15 to October 15 require a total of 837.6° to 1,510.8° over 43°F. to hatch, while those laid in April and May require from 981.6° to 1,139.1° accumulation. Were the moisture factor also considered, it is evident that the range of such an accumulation is too large to make it of much practical value, except by always using the minimum possible.

Thus if we are to relate the phenomena of insect growth and activity to temperature, we may say that they will be *about* so and so between certain temperatures or at certain seasons when such temperatures normally prevail, as Hunter and Hooker have done in the case of the cattle tick. Or, if we wish to be exact, we must secure the temperature curve for the species, based on the observation of a considerable number of individuals kept at different constant temperatures, or possibly better at temperatures having a diurnal variation with constant maximum and minimum, and with fairly constant moisture conditions. That the moisture factor must not be neglected is shown by the work of Hennings (lc.) and by that of E. C. Cotton, on the cattle tick, presented before this association, but never published.

With such a curve plotted it would be possible to give each degree of temperature for whatever time unit used, a definite valuation in relation to the accumulation of temperature necessary for any stage of growth or activity at the optimum temperature. Thus in the case of the cattle tick, see figure 26, if the optimum be considered to be 28°C. at which temperature 21.5 days are required for the eggs to hatch, then each day at 28°C. has a value of 4.65% of the whole, or .0465. As twenty-five days are required at 25°C., each day at 25°C. has a value of .04, and so on the value of a day at 20°C. is .02, at 15°C. is .01, and at 11½°C. is .00666. A table for the value of the degrees between these points may now be made so that the valuation of every degree to be considered may be given. Using these values, when an accumulation of 100% or 1 has been secured the true "thermal constant" should have been reached, for all the time relation to the varying temperatures has been reduced to a common unit. Were the effect of moisture similarly studied so that the effect of different

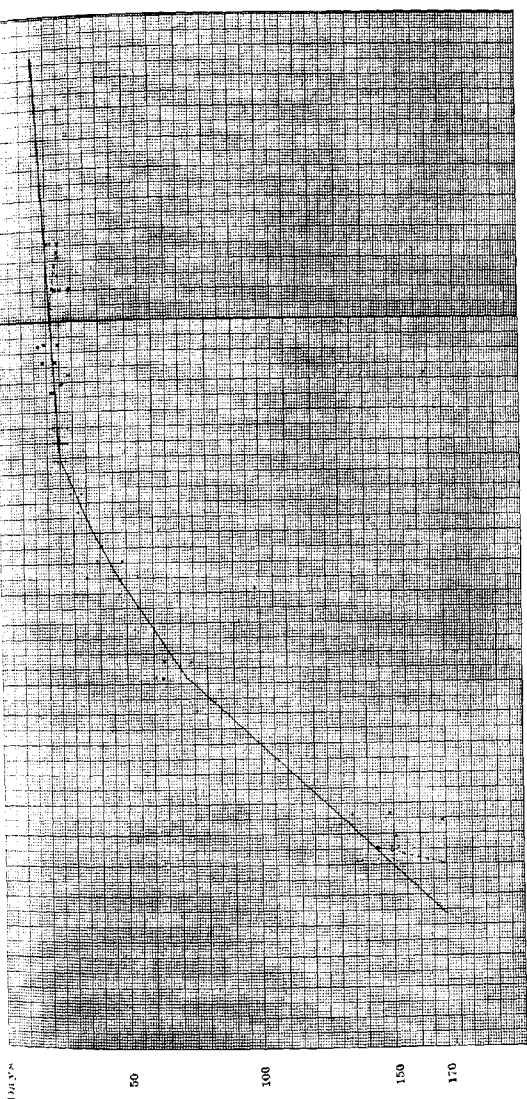

Fig. 26. Relation of temperature to the incubation of the eggs of *Margaropus annulatus*; . . . from Hunter and Hooker (Dallas, Tex., 1906), x from Newell, Baton Rouge, La., 1905–06 (original).

degrees of moisture at each degree of temperature were known, it should be possible to give a valuation for each degree of temperature which when the total equalled 100% or 1 would give the true physiological constant for the stage of growth or activity concerned. Such a proceeding would, of course, be entirely impractical except in the case of an insect of great economic importance in the control of which the application of such data would have immediate practical value, as in the case of the cattle tick. But if we are to deal with temperatures in relation to entomological phenomena, and are to give the matter any study at all, we may as well seek to have an understanding of the principles concerned even though we may not always use them in an exact manner. How closely accumulations of temperature values made by the above method will agree with the observed phenomena under varying conditions the writer has not had opportunity to determine, though the computations are now being made. The method seems, however, to be much more exact from a theoretical standpoint, than any heretofore advanced, and whether it includes all the factors necessary to determine a thermal constant or not, it is evident that some such process of computing the values of each degree of temperature from a curve established for each stage of growth, and by which they are reduced to a common basis, must be used before there is any possibility of securing a thermal constant for any given phenomenon of growth where subject to varying temperatures.

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MR. HEWITT: I should like to thank Professor Sanderson for his most interesting paper on the relation of temperature to the growth of insects. I think one of the most important features of his address is that he has given a very excellent summary of Bachmetjew's

work, which, although well known to some of us, may not be known to many practical entomologists, and he has pointed out lines which can be followed up by those who wish to study insect control, and I believe that in a few years we shall have results of a practical value accruing from these studies. One of the most difficult insects to control at present is the fruit fly, or apple maggot (*Trypeta pomonella*), and it is stated by Mr. C. P. Lounsbury, Cape Colony, South Africa, that by keeping the fruit for three weeks at a low temperature, the contained maggots of *Ceratatis capitata* were killed. I should like to suggest that temperature records should be kept in Centigrade rather than Fahrenheit, as the former is the method which is now used on the continent for all scientific work.

In studying a number of Dipterous larvæ upon lines similar to those of Professor Sanderson, I have confirmed the idea that the different stages of life history, such as larva and pupa, are all individually affected by temperature, and that temperature affects the life history, not as a whole, but by affecting each instar and stadium individually.

I think we are all extremely indebted to Professor Sanderson, and I wish again to offer him my sincere thanks.

SECRETARY BURGESS: I think this paper is very important, and one with which we should get in close touch. It is one, however, which requires considerable study. The matter of temperature plays a very important part in the parasite work which is being conducted at the Gipsy Moth Parasite Laboratory.

PRESIDENT BRITTON: We will now listen to a paper by E. C. Cotton, Knoxville, Tenn.

A CONSTANT LOW TEMPERATURE APPARATUS FOR BIOLOGICAL INVESTIGATIONS

By E. C. COTTON, *Knoxville, Tenn.*

One would probably be well within the truth in saying that every working entomologist has "pigeonholed" several fundamental problems in economic entomology the solution of which he has been obliged to defer because of the lack of funds, time and special apparatus. The passage of the Adams Act by the National Congress made it possible to commence the solution of some of these basic problems, most of which will require several years to complete. Under the provisions of this Act men in the experiment stations all over the country are devoting their whole time and energy to the working out of single

problems, and, what is more promising of results, they are usually provided with ample funds to secure the special apparatus needed in their work.

At the Tennessee Station we have one of these problems and for the solution of certain phases of it we soon discovered that apparatus for securing and maintaining constant low temperatures was essential. A careful search through the catalogs of both domestic and foreign firms dealing in laboratory supplies convinced us that there was nothing on the market to satisfy our particular needs. Incubators and other devices for securing and maintaining constant temperatures above the melting point of ice were listed by all of them but nothing for temperatures below that point. We then set to work to devise and construct a piece of apparatus for this purpose, which, because of the intense interest expressed by those who have seen it in an incompleted condition and its wide applicability to biologic problems, it has seemed advisable to describe at this time.

Our particular problem concerned itself with the North American Fever Tick and the effect of low temperatures upon the various phases of its life cycle. We know that a certain low temperature is fatal to all engorged adult ticks under a given set of conditions and also that a lower temperature under another set of conditions will not seriously affect them. Why? What are the governing factors and under what conditions do they act? We know that low temperature inhibits egg laying. What is the critical temperature for this function? Ever since the successful application of the law of accumulated effective temperatures to the boll weevil problem, there has been a demand from those engaged in tick investigation work for a similar law relating to the fever tick. Mr. Hunter's paper entitled "A Tentative Law Relating to the Incubation of the Eggs of *Margaropus annulatus*," which was presented before this Association two years ago, was an attempt to satisfy that demand. Recently we have attempted to apply this law to the immense mass of data accumulated at the Tennessee Station during the past three years, but I cannot flatter myself that we have achieved any great success. The trouble is that the upper and lower limits are too far apart and the exceptions too many and too serious. There seem to be some controlling factors which we have not yet mastered. What are they? These are all questions of vast importance from an economic point of view and moreover questions that must be answered if we are to know the fundamental laws on which to base a more successful scheme of tick eradication.

Various investigators have felt the need for low temperature con-

trol and have used many devices to secure this end. Among other things ice cream freezers and domestic refrigerators have been drafted into service, the cooling agent in all cases being ice with or without salt. In this way they were able to secure temperatures down to the melting point of ice, but anything like constant temperatures below about 42° or 43° Fahrenheit were out of the question. This method is very unsatisfactory at best, as it requires a great deal of personal attention and introduces the factor of human fallibility. As we wished to go below 32°F. and to maintain the temperature constant for long periods of time we soon saw the necessity of artificial refrigeration.

The list of active agents used in artificial refrigeration is not an extensive one, hence our choice of the gas we would use was not difficult. Anhydrous ammonia, which is probably the most widely used agent, was soon eliminated for the reason that our plant was to be installed in the basement of the agricultural building, in which, in addition to the laboratories for the regular Station workers, are located class rooms and laboratories for the accommodation of a large number of students. The presence within this building of any considerable quantity of so penetrating and irritating a gas as ammonia could scarcely be attended with anything less than serious inconvenience. Then, too, in our investigations we are dealing with living animals, hence small leaks, which are almost sure to occur when working with high pressures, might result disastrously.

Sulfur dioxid was soon disposed of for the reason that the gas is highly poisonous and also that the compressor using it operates with a partial vacuum on the low pressure side. While this machine is quite efficient when air can be kept out of the system every one recognizes the fact that a vacuum is very difficult to maintain and a little air leaking in seriously lowers the efficiency.

This process of elimination left only carbon dioxid, which was finally chosen. Safety and non-offensiveness of the gas were the principle factors in this determination. With this gas leaks of considerable magnitude can exist without serious inconvenience to the operator or other occupants of the building. There is also practically no danger that the insects or other life under investigation will be killed off in the middle of an experiment requiring several months to complete, even if the whole charge of gas were to escape into the room.

The plant (Pl. 6) consists of a compressor of two tons refrigerating capacity, a 7½-horse-power motor, a brine tank of 200 gallons capacity containing the expansion coils, a brine pump and an insulated box containing four chambers, each supplied with cooling coils

through which the brine circulates. The flow of brine through each of these coils is controlled by a balanced valve operated by a thermo-regulator.

The compressor is of the two-cylinder upright type and when in operation the high and low pressure sides stand at 70 and 30 atmospheres respectively. The machine is so strongly constructed that there is no special danger attendant upon its operation at these high pressures. A motor of 6½-horse power is required to operate this machine and a reserve of at least 1-rated horse power should always be allowed for a compressor of this size, more for larger sizes.

The brine system consists of a brine tank, pump, coils and the necessary piping to connect them. The brine tank is constructed of 3-16-inch boiler plate, is 3 feet in diameter and 4 feet high and contains 200 lineal feet of expansion coils giving a radiating surface of about 68 square feet. This tank holds approximately 200 gallons of calcium chlorid brine, which we are using in preference to sodium chlorid brine because the latter is so destructive to iron piping. The brine piping, with the exception of the coils in the chambers, which are 1 inch, is ¾-inch galvanized water pipe (Pl. 7.). The brine tank, piping and pump are well insulated against loss of cold by a wrapping of two thicknesses of 1-inch hair felt with one layer of waterproof insulating paper between. A tight-fitting cloth cover is then fastened over the whole and painted to keep out moisture (Pl. 6).

The brine is circulated by an automatic water lift or pump, operated by city water pressure. The pressure of the brine in the pipes, between the pump and the balanced valves, is automatically maintained equal to that of the water acting on the pump. When any one of the four valves is opened the brine flows through, reducing the pressure and starting the pump, which continues to operate until the valve closes and the pressures in the water and brine systems again balance. The brine tank thus serves as a storage reservoir for cold, which is automatically fed into the coils as needed to maintain the desired temperatures in the chambers.

The insulated chambers consist of a box 10 feet long, 3 feet wide and 3 feet high, the interior of which is divided into four compartments, each 2 feet square inside. The outside walls consist of an outer and an inner casing of ⅞-inch matched pine ceiling with four thicknesses of 1-inch hair felt and five layers of waterproof insulating paper alternating between. The inside partitions, between the chambers, are built up of two walls of ⅞-inch matched pine ceiling with three thicknesses of 1-inch hair felt and four of paper alternating between. Each of these chambers is to be maintained at a dif-

ferent constant temperature: No. 1 at 60°, No. 2 at 50°, No. 3 at 43° and No. 4 at 32°. The radiating surfaces of the coils were estimated to easily maintain these temperatures, being 453, 733, 1,153 and 1,453 square inches respectively.

In one side of each chamber is a door 15 inches each way, which seats on two felt-lined surfaces and is fastened by the usual eccentric refrigerator door hasp. In each door is a window, 9 by 10 inches, containing six panes of glass with five air spaces between (Pl. 8).

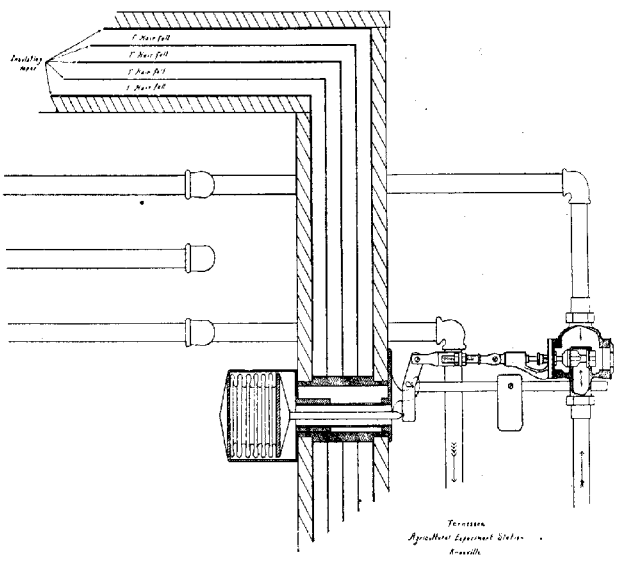
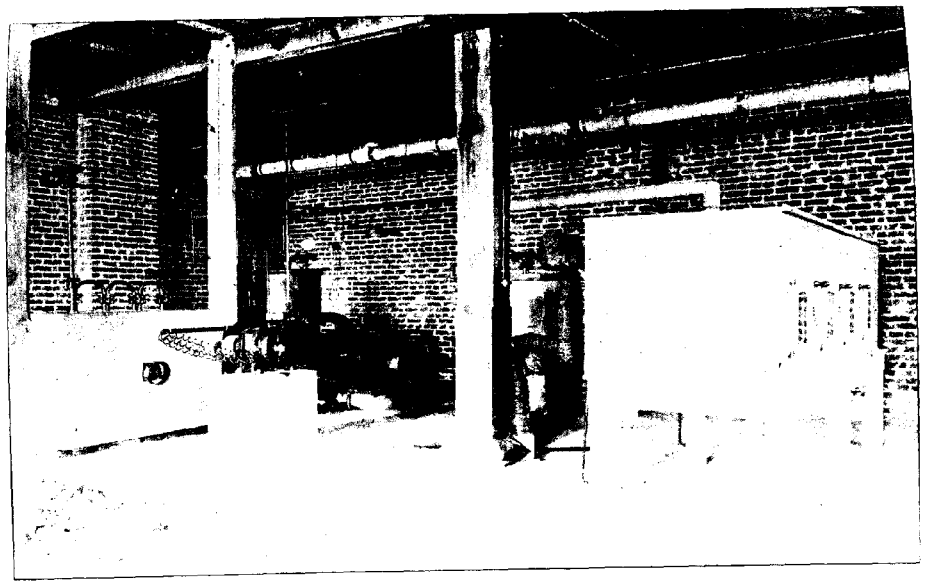


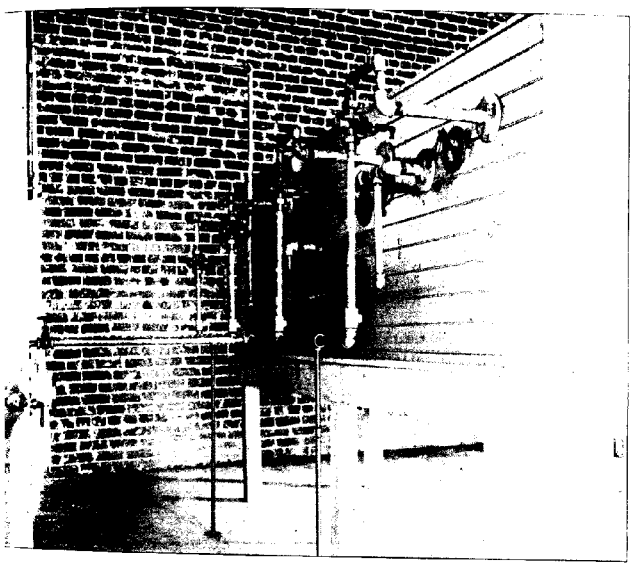
Fig. 27. Section through wall of cool chamber, showing thermo-regulator and balanced valve with connections.

The insulation of these chambers is so nearly perfect that there can be but little loss through the walls.

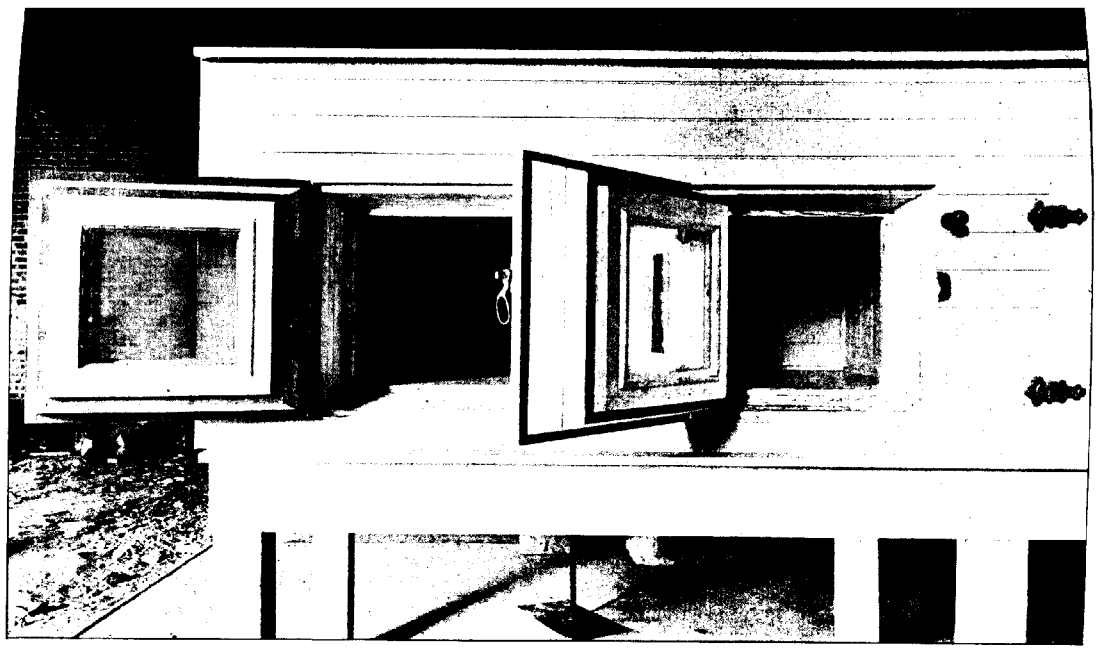
The desired temperatures are secured by pumping the cold brine through the coils, which are placed in the upper part of the chambers. This arrangement allows the free use of the floor of the chamber and also locates the coils at the point of highest temperature and theoretically should yield the best results. Inside the chambers and just below the coils are located the bellows of the thermo-regulators. This location gives a quick response to any changes of temperature of the coils themselves.



View of complete plant



ck side of cool chambers showing brine piping and balanced valves before insulation was applied



Front view of cool chamber showing construction of doors

The thermo-regulators, which are the vital part of the plant, were made by a local firm. The mechanical principle involved constitutes the most important forward step in temperature control that has been made in the past century. They are simple, extremely sensitive, reliable and almost indestructible if properly handled. The regulator is in the form of a very thin, steam brass bellows about 5 inches in diameter and 3½ inches high and is partly filled with an easily volatilized liquid after which it is hermetically sealed.

A rise in the temperature of the air in the chamber causes a portion of the liquid to volatilize, exerting an expansive pressure on the bellows, which is so housed that it can expand in one direction only. To the free end of the bellows is fastened a pin which extends through the wall of the chamber, and engages the lower end of a rocker arm to the upper end of which is attached the stem of the balanced valve.

The balanced valve remains closed so long as the air in the chamber is at or below the temperature for which the bellows is adjusted. When the temperature rises above this point the bellows expands, exerting a thrust against the lower end of the rocker arm, opening the valve and allowing the cold brine to flow through the coils until the temperature again falls to the predetermined point. Adjustment is secured by means of a 5-pound sliding weight carried on a rod 12 inches long, projecting at right angles to the rocker arm (Fig. 27).

In actual practice the valve is probably never opened wide. The rising temperature begins to act on the liquid in the bellows before the temperature for which the latter has been adjusted is reached. This opens the valve the merest trifle, allowing a very thin stream of the colder brine to pass through and mix with the body of brine already in the coils, reducing its temperature and closing the valve before enough brine has passed through to entirely replace that present when the valve began to open. A pressure of 10 to 15 pounds on the brine system admits of a more sensitive control than a higher one because with the higher pressure the whole body of brine in the coils is pretty sure to be replaced by brine several degrees colder before sufficient cold radiates from the coils to close the valve, consequently the temperature of the air in the chamber will be carried several degrees below the desired point before the balance is again established between the brine and the air.

MR. CONRADI: I would like to ask the cost of this low temperature apparatus, as described.

MR. COTTON: About fifteen hundred dollars.

MR. CONRADI: And what is the daily cost of operation?

MR. COTTON: About seventy-five cents.

PRESIDENT BRITTON: The next paper on the programme is by Mr. E. F. Hitchings, Waterville, Me.

THE UNPRECEDENTED APPEARANCE OF THE SADDLED-PROMINENT

(Heterocampa guttivitta)

By E. F. HITCHINGS, *Waterville, Me.*

Past History. This insect has appeared in the writings of eminent entomologists under at least five different genera and ten different species, but it has never been regarded as of enough importance to receive a common name until the season of 1908, when, on account of its extensive ravages in Maine, it was by mutual agreement of the Experiment Station and the Maine Department of Agriculture called the Saddled-prominent.

Doctor Felt, in his twenty-third report of New York, has suggested the name "Antlered maple caterpillar." This is open to criticism, for in the first place the caterpillar remains in the antlered stage for only a few days, in the second place maple is not its favorite diet. It prefers beech above all other food plants. During the recent invasion it fed freely on such other trees as oak, white and yellow birch, maple, hornbeam, hazel, apple, pear, plum, cherry, etc.

The insect was first named by Walker in 1855. Beginning in 1864, Packard assigned it to no less than two genera and five species, while Walker seemed to vie with him and placed it under three genera and four species. It did not come into prominence sufficiently to be mentioned in *Insect Life*.

Distribution. I quote from the fifth report of the Entomological Commission: It was reported as found feeding on white oak October 9 at Providence, R. I. "Found on sugar maple July 10 at Brunswick, Me. The egg was found July 3 on the red maple at Brunswick, Me." Hatched July 10th. Packard quotes in a footnote from Dr. Dyar: "I have twice found a peculiar variety of *guttivitta*, one at Woods Hole, Mass., one at Jefferson, N. H., in which a large brown dorsal patch was retained in the last stage." Riley reported it in Maryland on oak, hickory, walnut and birch on July 9, 1882. French found it in Union County, Ill., on June 20. The above quotations

... to prove that the insect has never occurred in great abundance at any one period.

Extent of Infestation. According to the writings of Doctor Felt in New York and Professor Sanderson in New Hampshire this pest has apparently been working its way east across northern New York, Vermont and New Hampshire. From thence it has come into Maine. This outbreak was first noticed in 1907. It appeared on the New Hampshire border at Fryeburg, and extended into Androscoggin, Kennebec and Somerset Counties a distance of over 150 miles. In some sections this strip was at least fifty miles wide. Its ravages are confined principally to the ridges of hard wood growth. Whole woodlots of from ten to several hundred acres have been stripped bare of foliage. It has been a serious blow to the maple sugar industry of Maine. In one sugar berth in Sidney the owner reported stripping of the tops of the trees in 1907. The following spring 3,000 trees were tapped. In the summer of 1908 the trees were completely denuded, but put out a second crop of leaves in the fall. The same trees were tapped last spring and allowed to run the same length of time as on the previous season with the result that only about forty per cent. as much syrup was secured. The trees were again partially stripped during the past season. Undoubtedly many of them will not survive the shock.

A fifty-acre woodlot of beech which had been stripped more or less completely for three seasons when examined the past fall showed at least fifty per cent of dead trees.

Orchard Injury. The damage done has not been confined to forest sections, but orchard and shade trees have suffered alike. In many instances whole orchards have been completely stripped of leaves, the fruit standing out on the branches as lone sentinels of the destruction wrought. One orchard that was stripped during the past season was visited on the first of October and the trees were found in full bloom again. Nature was endeavoring to reëstablish the promise of seed time and harvest under very discouraging conditions.

Life History. The life history of this insect is much the same as that of others of the same family, so that it seems unnecessary to go into it in detail. From my notes of 1909 I select the following: "Moths were flying in abundance during the last week of June. Were attracted to light and remained at rest on the house during the day. On June 30th in the orchard of F. H. Morse of Waterford, Oxford County, found many eggs. They were laid singly on the under side of the leaves and a curious fact was noted that but a single egg was found on a leaf, although there were thousands of

moths in that section. The eggs are much flattened and are attached very firmly. About fifty per cent of the eggs were hatched and some few had passed the first molt. The owner was instructed to spray his orchard immediately with lead arsenate, 2 lbs. to 50 gallons, but failed to do so until about three weeks later, at which time it took a double dose of the poison to successfully control the caterpillars.

"On July 27th, 1908, visited the orchard and woodlot of Nathan Sanborn in Cumberland County. Found several hundred acres of beech, oak, etc., stripped, while hundreds of apple trees were bare and the elms and maples about the house were being defoliated. Turkeys, geese and chickens were busily engaged in adding their mite to the exterminating process. A chicken caught by a hawk but released by the hawk being frightened, was dressed off, a post mortem examination revealed seventy-five full grow caterpillars of *H. guttivitta* in its crop. The chicken weighed when dressed only one and one-half pounds.

Associates. Associated with *H. guttivitta*, in many cases in great abundance, were *Anisota virginiensis* and *A. rubicunda*, together with *Symmerista albifrons*.

Enemies. Among the enemies noted were a few birds (I believe the great scarcity of birds during the last few years accounts for the wide devastation by this pest) predaceous bugs, especially *Podisus modestus* and beetles of which *Calosoma calidum* and *C. frigidum* took the leading part, were quite numerous. Hymenopterous parasites were much in evidence, so were Tachinid flies, but the leading controlling factor was the presence of a fungous disease which was so effective that whole colonies were practically wiped out. Our friend, the skunk, was busy in some sections. In one instance where a heavy growth of hard wood was completely stripped, no pupæ could be found, the ground being dug over completely, apparently by skunks and foxes.

Future Outlook. All appearances at the present time point to an early control of this phenomenal outbreak by the above named agents.

MR. FELT: I just want to call attention to Mr. Hitchings' remarks in regard to the absence of insectivorous birds, and to state that we have in New York for the last decade suffered greatly from leaf eating caterpillars, presumably on account of the great scarcity of birds.

I understood Professor Hitchings to give voice to the sentiment that this caterpillar spread from New York and New Hampshire to Maine. It seems to me the insect became unusually abundant over a large

area at once. In other words, it is not a migration, but an unusual development due to favorable climatic conditions or to the absence of natural enemies.

PRESIDENT BRITTON: Doctor Hewitt will now present his paper on the Larch Saw Fly.

THE LARCH SAW FLY (NEMATUS ERICHSONII)

By C. GORDON HEWITT, *Ottawa, Canada*

[Withdrawn for publication elsewhere]

MR. S. J. HUNTER: The speaker, in introducing his remarks, stated that this species was parthanogenetic. I would like to know upon what grounds he bases this statement.

MR. HEWITT: By the simple fact that no males were present, and also from the fact that I have reared larvæ from unimpregnated females.

Afternoon Session, Wednesday, December 29, 1909

Meeting called to order by President Britton at 1.00 p. m.

PRESIDENT BRITTON: The next paper on the programme will be presented by Mr. T. J. Headlee, Manhattan, Kansas.

NOTES ON THE CORN EAR-WORM

By THOMAS J. HEADLEE, *Manhattan, Kan.*[1]

The fact that corn, which is one of the main sources of income to the people of Kansas, has suffered a damage of about 3.5 per cent to each of the last three crops through the ravages of this insect, coupled with the acknowledged fact that no satisfactory method for its control on corn has been devised, has compelled the writer to plan a study of the corn ear-worm for the purpose of finding how it may be controlled. Undertaking the study of this problem was

[1] The writer desires to acknowledge the aid rendered him by his student assistant, Mr. Walker McColloch, who under his immediate direction carried out the details of this study, the practical results of which are recorded in this paper.

rendered still more urgent through the discovery[2] made by our veterinary department that intravenous introduction into horses of certain molds and bacteria found growing on the excrement of the larva in many cases produces symptoms of blind staggers, and that introduction per orem produces well marked cases. As the research has gone forward, the writer has become increasingly aware of the magnitude of his task. He has come to see it as one requiring the most fundamental sort of study for its completion. He has no thought of attempting to offer at this time a complete solution for the problem, but hopes merely to set forth briefly a method by means of which this insect's injury to corn may be materially reduced. Only such facts of the corn ear-worm's life history and habits as are necessary to the development of methods of control will be considered in this paper.

A majority of the third brood of larvæ enter the soil and prepare their winter burrows as has been described and illustrated by Quaintance and Brues.[3] The pupæ into which they transform average three and one-half inches below the surface with one and seven inches as extremes. (This average was determined by the examination of 503 pupæ collected from different cornfields about Manhattan during the springs of 1908 and 1909.) Here they remain until June of the following year. Having found the larvæ feeding in great abundance in weed patches and alfalfa fields in the early fall of 1908, the writer fully expected to take the pupæ in such situations. Although last spring a 10′ x 10′ area in a patch of velvet leaf, which in the fall of 1908 was infested with many larvæ of various sizes, and several 5′ x 5′ areas in alfalfa, where in the fall of 1908 the moths deposited their eggs thickly, were selected and carefully examined, nothing could be found. It is probable that parasitic enemies and sharp frosts destroyed the larvæ. The data thus far accumulated indicate that the corn ear-worm hibernates mainly in the soil of infested cornfields. The number of pupæ varies directly as the field examined has been slightly or badly infested, and although more than one half perish before emergence time from one cause or another, enough survive as a rule to infest almost one hundred per cent of the ears of the new crop without outside aid.

The moths begin to emerge in late May and reach maximum emergence in early June. Very soon after fertilization the females deposit

[2] Dr. F. S. Schœnleber and assistants, chief of whom may be mentioned Mr. Thomas P. Haslam, of the veterinary department, Kansas State Agricultural College, have recently found this to be the case.

[3] 1905, Quaintance and Brues, Bul. No. 50, Bu. of Ent., U. S. Dept. of Agric.

eggs on various useful plants and on weeds, but seem to prefer corn plants to anything else. Indeed, so emphatically is this the case that from the date of emergence to the hardening of the corn, few eggs are laid anywhere else in the vicinity of cornfields. Until silking begins the eggs are placed on the corn blades and the larvæ feed on the tender curl of the corn. After silking commences the eggs are laid almost exclusively on the silk. After the silks dry and shrivel, so long as the stalk, blade and husks remain green, a few eggs are deposited. Gradually all such oviposition ceases and the moths turn their attention to various weeds in and around the cornfields and to adjacent fields of alfalfa. At this time they deposit hundreds of eggs on alfalfa, red clover, velvet leaf, foxtail, bladder ketmia, lamb's quarters, sunflower, soy beans, millet, Amaranthus, sp. and smartweed (*Polygonum pennsylvanicum*).

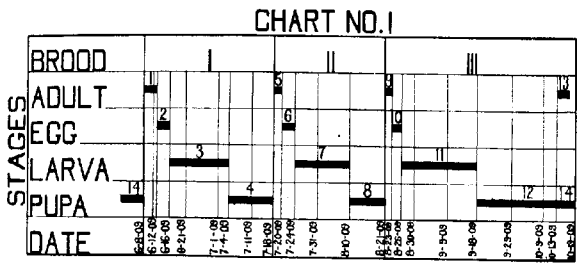


Chart No. 1.—Diagram showing the possible number of broods of corn earworm at Manhattan, Kan. 1=pair of first-brood adults from emergence to oviposition; 2=the average of 40 eggs from deposition to hatching; 3=the average of 10 larvæ from hatching to pupation; 4=the average of 9 pupæ from pupation to emergence of adult; 5=pair of second-brood adults from emergence to oviposition; 6=the average of 30 eggs from deposition to hatching; 7=the average of 10 larvæ from hatching to pupation; 8=the average of 10 pupæ from pupation to emergence of adult; 9=pair of third-brood adults from emergence to oviposition; 10=the average of 25 eggs from deposition to hatching; 11=the average of 11 larvæ from hatching to pupation; 12=the average of 9 pupæ from pupation to emergence of adult; 13=pair of fourth-brood adults from emergence to oviposition; 14=that portion of the third brood of pupæ which forms the overwintering brood.

While there is no doubt whatever that the larvæ prefer corn and will be found upon it so long as it is present and sufficiently succulent for food, there is also no doubt that they are able to develop upon a diet of alfalfa, bladder ketmia, velvet leaf and sorghum and are able to finish their growth on many species other than these. From the time the larvæ appear until the corn grows too hard for

their liking they are found elsewhere only occasionally. After the corn ripens they may be found in great numbers in alfalfa, in patches of velvet leaf, on bladder ketmia, and on ground cherry. This fall they were especially abundant in alfalfa.

The possible number of broods was determined in an outdoor screen insectary by getting eggs from the first moths that emerged in the spring which would oviposit in confinement, breeding these through to moths, taking eggs from the first to emerge, and so continuing throughout the season. Chart No. 1 will serve to give a summary of the results.

Examination of this chart shows that the insect experiences three full broods and a partial fourth at Manhattan. The first extends from June 8, 1909, to July 18, 1909, occupying 40 days, under an average mean temperature of 76.1°F. and relative humidity of 78.6°; the second from July 18, 1909, to August 21, 1909, occupying 34 days, under an average mean temperature of 77.6°F. and relative humidity of 77.2°; the third from August 21, 1909, to October 13, 1909, occupying 53 days, under an average mean temperature of 72.8°F. and relative humidity of 67.3°F. The fourth brood is only partial and the young do not reach maturity. Most of the third brood of pupæ do not transform to adults in the fall but remain in the ground as the overwintering brood.

The actual number of broods has been determined by making frequent and regular countings of the number of eggs borne by corn plants of different ages and by observing the prevalence of moths and the age of larvæ in the field. The variation in the number of eggs per corn plant for different counts is not sufficiently pronounced to reveal the presence of very distinct maximums indicating distinct broods until the tremendous increase due to the arrival of the third brood appears. The results of plotting the counts for 1908 and 1909 from field corn and constructing curves are shown in chart No. 2.

The observer experienced difficulty in the field in separating the first brood from the second, and still more in separating the second brood from the third, and after the arrival of the third lost all distinction between the broods. From the time the third brood came on moths could be found in large numbers and eggs and larvæ in all stages at any time. The number of broods as determined by field observations alone is three, but a partial fourth might very well occur as all above-ground stages of the insect may be found until heavy frosts.

Study during 1908 had indicated: (1) that early winter plowing would, as has been stated in the literature of this insect, greatly

duce the number of such overwintering pupæ as would survive, undisturbed; (2) that the keeping down of weeds in the cornfields, along fences and over neglected places might prevent those larvæ

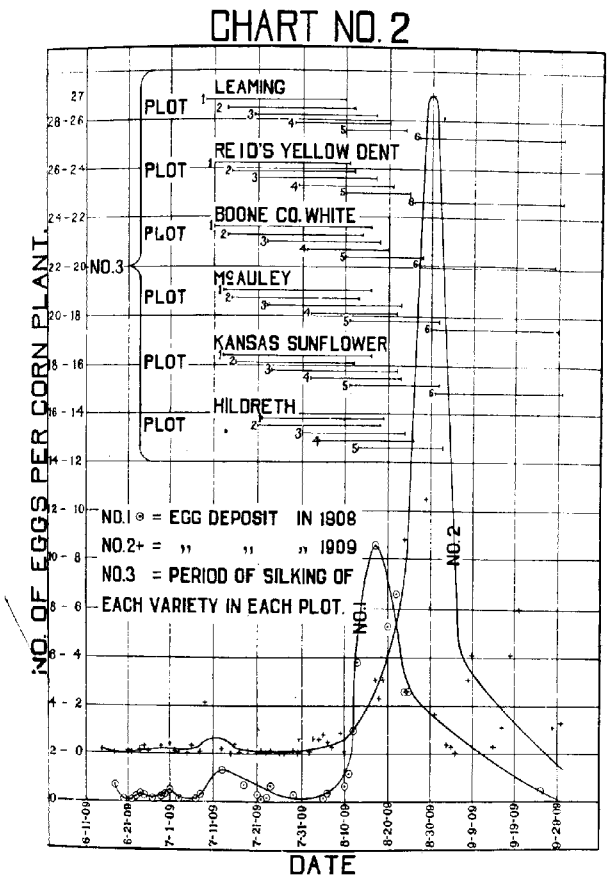


Chart No. 2.—Deposition of eggs on field corn in relation to time of silking of each variety in each plot.

which develop after the corn is ripe from reaching maturity, and that disking the alfalfa in early spring might destroy such as transform to pupæ in alfalfa fields, thus greatly reducing the numbers of the pest; (3) that early planted corn was less injured by the larvæ than

corn planted later and that this difference was probably due to the fact that the early planted corn finished its silking before the third brood came on in full force.

In support of finding No. 1, it may be said that in the spring of 1909 four 10′ x 10′ plots, examined in a field which on September 22 of the preceding fall showed sixty-four per cent of the ears infested and which had been plowed in early winter, gave no living pupæ; while two 16′ x 16′ plots in a field which showed a somewhat larger per cent of infestation the preceding fall and which was undisturbed until spring showed six living pupæ.

In regard to finding No. 2 it may be said that while, as stated earlier in this paper, our examinations indicate that most, if not all, the pupæ of corn ear-worm winter in the soil of infested cornfields, there is no doubt that the presence of weeds in and around the corn enables many belated larvæ to finish their growth. Weeds, therefore, should not be tolerated in such locations. The parasitism of the larvæ infesting weed patches and alfalfa fields, particularly the latter, in the autumns of 1908 and 1909 has been exceedingly high and the early hard frosts have destroyed large numbers. Possibly these agencies may account for the absence of pupæ in such places.

In order to determine the exact relation existing between time of planting and injury and to find out the exact cause of this difference, six standard varieties of corn were planted at different periods. A two and one-half acre plot of ground of uniform character was selected and divided into six plots. In each plot three 150-feet-long rows of each of the six standard varieties of corn were planted. These strains ranged from one hundred and fifteen to one hundred and thirty-five days in time of maturing. They were Leaming, Reid's Yellow Dent, Boone County White, McAuley, Kansas Sun Flower, and Hildreth. The land had previously been in use for wheat breeding. The soil was prepared by spring plowing and working. The corn was cultivated at first deeply, then shallowly, and kept thoroughly clean to the end of the season. The plots were planted as follows: Plot No. 1 April 15th; plot No. 2 May 1st; plot No. 3 May 15th; plot No. 4 June 1st; plot No. 5 June 15th; plot No. 6 July 1st. Except for cold weather in the spring, some wind and hail in July, the season was excellent for corn production until the middle of August when the drought became so severe that the yield of plot No. 6 was practically ruined. Plot No. 1 produced corn on cob at the rate of 39.5 bushels per acre; plot No. 2 46.5 bushels; plot No. 3 49.7 bushels; plot No. 4 46.7 bushels; plot No. 5 26.1 bushels; and plot No. 6 corn hardly worth gathering. Plots No. 3 and No. 4 produced more corn

than plot No. 2 because they experienced less harm from hail and wind. After ripening the corn was gathered into bags, keeping each row separate, and the damage carefully determined. First the average percentage of ears infested in each variety of each plot was determined, then the average percentage of grains destroyed on infested ears of each variety in each plot. The results are graphically represented in charts Nos. 3 and 4.

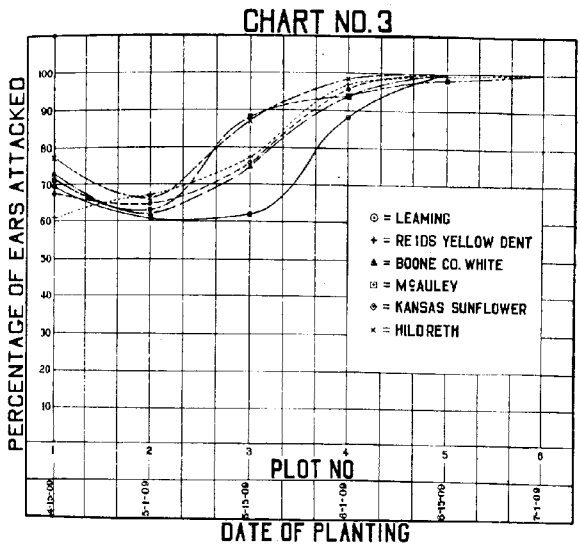


Chart No. 3.—Percentage of ears produced by each variety in each plot infested by one or more larvæ.

Chart No. 3 clearly shows that the corn in plot No. 2, which was planted May 1st, experienced the smallest percentage of infestation, and that the infestation became constantly greater as the time of planting grew later. Chart No. 4, while the curves are very irregular, shows that in general the smallest number of grains destroyed on infested corn was to be found in corn planted May 1st.

Thus it is seen that both the largest number of clean ears and the largest number of sound grains per infested ear were produced in corn planted May 1st.

To be more exact it may be said that corn planted May 1st produced 6.1 per cent more of its total number of ears clean than that planted April 15th, 14.6 per cent more than that planted May 15th, 30.5 per

cent more than that planted June 1st, 35.8 per cent more than that planted June 15th, and 36.2 per cent more than that planted July 1st; and it may also be said that the corn planted May 1st lost 1.3 per cent less grains from ears that were infested than that planted April 15th, 1.2 per cent less than that planted May 15th, 3.1 per cent less than that planted June 1st. The outcome of this experiment

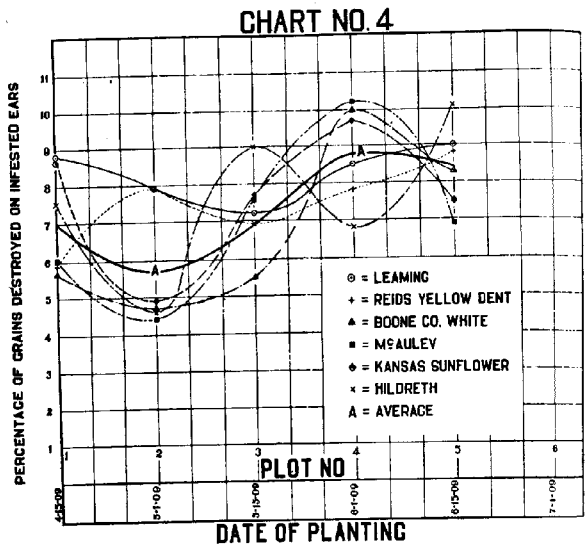


Chart No. 4.—Percentage of grains destroyed on infested ears of each variety in each plot.

indicates that early planting on uninfested or cleaned soil will reduce the corn ear-worm damage about 40 per cent.

Chart No. 2 shows not only the egg laying of the actual broods, but shows this feature in relation to the time of silking of each variety in each plot. It will be noted that plots 1 and 2 finished silking before the third brood of eggs were deposited and reference to charts No. 3 and No. 4 will show that they experienced the least injury. Plot No. 1, with the exception of Hildreth, in which silking came much later than others, remained in silk longer than plot No. 2, thus exposing it for a longer time to oviposition with resulting greater damage. The silking of Hildreth in plot No. 1 is sufficiently later to account for greater injury. Plot No. 1 received a "set-back" from

cold weather which no doubt accounts for its relatively slow growth. In plots No. 3, No. 4, No. 5 and No. 6 the damage is progressively greater as silking comes more and more completely into the time when the third brood is active.

The reason, then, that early planted corn experiences less injury than corn planted later lies in the fact that early planted corn passes through its most attractive stage — silking time — before the third and by far the largest brood has appeared, or at least before it has a chance to do its full work. The experiment further shows that corn planted so early as to get a "set-back" suffers more from this insect than if it were planted just a little later. Clearly the optimum time for planting is just as early as the corn can be put in the ground and escape injury from cold weather.

In summing up the practical results of this study, it may be said that the individual corn grower by planting his crop on uninfested or cleaned soil as early as the season will permit may reasonably expect to escape forty per cent of the injury he would otherwise experience.

PRESIDENT BRITTON: The next paper will be read by Mr. George G. Ainslie, Clemson College, S. C.

NOTES ON APHIS MADIRADICIS

By G. G. AINSLIE, *Clemson College*

[Withdrawn for publication elsewhere.]

PRESIDENT BRITTON: Mr. P. J. Parrott will now present his paper on the Ermine Moths.

THE CHERRY ERMINE MOTH

(*Hyponomeuta padella* L.)

By P. J. PARROTT, *Geneva, N. Y.*

During June, 1909, several cherry seedlings, completely covered with silken webs, were brought to the Entomological Department for examination by Mr. John Maney of the Division of Nursery Inspection. The unfamiliar appearance of the nests and the enclosed caterpillars, coupled with the fact that the specimens were taken from

a plantation of imported nursery stock, led to the conclusion that the insect was a foreign species, and probably an Ermine Moth. Some of the larvæ were kept in breeding cages to obtain some adults which began to make their appearance on July 9. These were compared with descriptions of various authorities, and the insect was identified as the Cherry Ermine Moth (*Hyponomeuta padella* L.), and a statement to that effect was published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 2. p. 305. To make certain the identity of the species which we had bred, several specimens of the moths were later sent to Dr. Paul Marchal of the Entomological Station of Paris, who confirmed our identification. This is the first time that the pest has been reported to exist in the United States, and the attention of entomologists is called to the circumstances of its introduction and discovery, and to the economic importance of the Ermine Moths as fruit pests.

General Characters of the Ermine Moths. These moths belong to the genus *Hyponomeuta* of the *Tineina*. There are only a few species but the genus is widely distributed. The moths are small, with an expanse of wings varying from twenty to twenty-five millimeters, according to the species. The anterior wings are snowy-white or greyish, marked with black dots, hence the name Ermine Moths. The hind wings are darker and have long fringes. The classification of the moths is attended with considerable difficulty because of the confusion which has prevailed in the synonymy and the exceeding variableness of the characters which distinguish the species. This is not surprising as the caterpillars and moths of one species resemble like stages of another. The caterpillars of several species have host-plants in common and life histories are very similar.

The caterpillars are gregarious and live within a silken web. The cocoons are spun in close proximity to each other in the nests.

Species Attacking Fruit Trees and Host-Plants. European writers have generally held that there are two common species which live on fruit trees, viz.—*H. malinella Z.* and *H. padella* L. The former is a common pest on apples. It has also been recorded as occurring on the wild service tree (*Sorbus tormenalis*) and Doctor Marchal[1] has reported its presence in destructive numbers on the almond (*Amygdalus communis*). The latter, popularly known as the Cherry Ermine Moth feeds principally on the cultivated plum, blackthorn (*Prunus spinosa*) and hawthorn (*Cratægus oxyacantha*). Other

[1] Marchal, Paul, Bulletin de la Société d' Etude et de Vulgarisation de la Zoologie Agricole, No. 4, p. 13–26. 1902.

host-plants mentioned by various writers are the cultivated and wild cherry, medlar, apple, *Sorbus aucuparia* and *Fraxinus excelsior*.

The moths of these two species are very similar in appearance and are frequently indistinguishable. Representative specimens of *malinella* have the front wings and the fringe white, while *padella* has the fringe and a portion of the front wings more or less tinted with greyish. Doctor Marchal is of the opinion that *malinella* is a variety of *padella*, which has adapted itself to the apple. Differences are also to be noted in other stages. Rebaté and Bernès[2] state that the caterpillar of *padella* is of a greyish-yellow in color, the cocoons are thin in texture, of a greyish-white color, and are more or less isolated in the nest, while the larva of *malinella* is lighter in color, the cocoons are thicker, and are grouped in clusters.

Other species attacking fruit trees are *H. mahalebella* Gn., which is common on the mahaleb cherry; *H. evonymella* L. (=*padi* Z.) which subsists on the European Bird Cherry (*Prunus padus*) and has been reported as occurring on the cultivated cherry; and *H. irrorella* Hb., which usually feeds on the willow and is said to have attacked cultivated plums.

A Native Species of Ermine Moth. There is one native species, *H. multipunctella* Clem., which according to Chambers[3] is very common in Kentucky. Dyar [4] records the Atlantic States as its range of distribution and Gaumer has obtained specimens of the species in Kansas. The caterpillar feeds on the leaves of *Euonymus atropurpureus* Jacq. and spins its webs over the plant as is characteristic of the insects of this genus. Through the kindness of W. D. Kearfott I have been able to examine specimens of the adults, which differ from the foreign species described by the larger number of black dots on the front wings and the marked difference in the coloration of the hind wings of the sexes. All the wings of the male are white, while the female has the anterior wings white and the posterior wings dark grey.

Economic Importance. The Ermine Moths are regarded abroad as very destructive pests of fruit trees, and because of their importance to horticultural interests, standard European works of reference on orchard insects usually contain a very complete account of these species. Marchal (1) reports that in certain areas of France *malinella* appears almost every year in more or less destructive numbers, and that in some communities where there have been serious outbreaks for successive years, almond trees have been killed. In 1902, *malinella*

[2] Rebaté, E. and Bernès J., La Chenille Fileuse du Prunier, p. 1–32, 1909.
[3] Chambers, V. T., Can. Ent., Vol. 4, p. 42, 1872.
[4] Dyar, H. G., List of N. A. Lepidoptera, p. 489, 1902.

and *padella* were very abundant and destructive throughout France. The species *mahalebella* is very common on the mahaleb cherry at Fontenay, and during some seasons the wild cherries in the hedgerows were entirely defoliated. During 1897 and 1901, this species was very abundant. Theobald[5] regards *malinella* and *padella* as important pests in England. The former was very troublesome in this country in 1865, 1877 and 1880, and during the first two named years whole orchards were devastated, the foliage being as bare as midwinter. The latter feeds normally on hawthorn, often quite defoliating the hedgerows. Saracomenos[6] says that a large number of fruit trees such as apple, pears and plums which are grown on an extensive scale on the Island of Cyprus are attacked by *malinella* and *padella*. These prove very injurious as they destroy the crops, and if they appear in numbers for a series of years they may cause the death of the trees themselves. The damage occasioned to apple and plum trees is always great. Rebaté and Bernès[2] report that outbreaks of *padella* occur periodically. In 1843 in Lot and Garonne all trees were attacked but in the following year the pest failed to appear. From 1867 to 1871, in 1882 and again in 1888 considerable damage was done by the insect. The outbreak of 1901 was followed by a more severe one in 1902, and it was not till 1904 that the insect was under the control of its natural enemies. During 1908 the caterpillars again increased to destructive numbers, and as was predicted serious depredations occurred during 1909. It is feared that greater damage will be done by these pests during 1910. Other writers comment in like manner on the destructive capacity of these insects.

Life Histories and Habits. The life histories of the different species are very similar. According to Marchal (1) the female *malinella* deposits her eggs during July on small twigs in oval patches about four or five millimeters in diameter. The eggs are covered with a glutinous substance which is at first yellow, but which gradually becomes brown, resembling the color of the bark. In each mass there are from fifty to eighty eggs, which are placed in rows, overlapping one another like tiles on a roof. Hatching takes place during early autumn, but the tiny caterpillars remain sheltered through the winter under the protecting crust of the egg mass. During the following spring the young larvæ abandon their hibernating quarters, and enter the expanding buds, where they assemble in numbers between the sepals of the calyx and petals of the blossom buds or between two

[5] Theobald, F. V., Insect Pests of Fruit, pp. 86–91, 1908.
[6] Saracomenos, D., Cyprus Journal, No. 11, p. 275, 1908.

leaves of the leaf buds. In the early part of May they then burrow into the parenchymatous tissues of the leaves. As many as a dozen of the caterpillars may exist in one colony. The presence of the pest is indicated at this time by the injured leaves turning red in spots. Later abandoning their mines, the larvæ feed openly on the foliage, and spin webs in which they live together in colonies. During the month of June the larger tents are formed, and in severe attacks the tree is stripped of its foliage, and is covered with a sheeting of the dirty, ragged remains of their discolored webs. The cocoons are spun side by side in the nest, in which the larvæ pupate and from which the moths commence to appear in early July. The life history of *padella* differs from that of *malinella* in that the larvæ are not leaf miners.

Distribution of the Cherry Ermine Moth. The Cherry Ermine Moth has only been found in one locality in the State of New York. Eight nests were obtained, and with the exception of a few caterpillars, which were kept in the laboratory to breed adults, the material was destroyed. Repeated examinations failed to find any more evidences of the insect in this plantation, which like all other plantings of foreign stocks, has been under very close supervision this year, because of the discovery during the early spring of nests of the Brown-Tail Moth among these same importations. Present knowledge indicates that the Ermine Moth has not established itself in this state.

Inspection of Foreign Shipments of Nursery Stock. The discovery of this insect is a good example of the importance and value of efficient inspection and of the need of a closer surveillance of foreign shipments of nursery stock. Owing to their destructive character, entomologists should be on the lookout for evidences of the Ermine Moths in nursery plantations, especially of recent importations, as these insects can be introduced in such shipments, and if once established they may prove a serious menace to our nursery and orchard interests.

For the protection of nurseries, inspectors should be on the alert for plants, enclosed with webs, which should be immediately uprooted and destroyed. Spraying with arsenicals has been found in France to be an effective remedy for the treatment of orchards.

PRESIDENT BRITTON: The next paper will be read by Prof. F. L. Washburn, St. Anthony Park, Minn., entitled "Further Observations on the Apple Leaf Hopper (*Empoasca mali*) and Notes on *Papaipema nitela* and *P. cataphracta*.

1. FURTHER OBSERVATIONS ON EMPOASCA MALI; 2. NOTES ON PAPAIPEMA NITELA AND P. CATAPHRACTA

By F. L. WASHBURN, *St. Anthony Park, Minn.*

FURTHER OBSERVATIONS ON EMPOASCA MALI

In a paper read before the Association last year the following statements were made concerning this insect, as the result of two years' work: (*a*) Fall laid eggs were not found on any herbaceous plant. (*b*) The insect winters only in the egg stage. (*c*) Oviposition in summer was found to occur on the petiole of apple and clover, with the probability of its occurring on other herbaceous plants. (*d*) List of food plants was given. (*e*) Five nymphal stages were reported, covering a period of about twenty-two days. (*f*) Adults may live fourteen days or over; (1907 experiments indicate that they may live thirty days or more). (*g*) The location and appearance of the winter egg blister, and the contained egg was discussed and illustrated. (*h*) Certain observations on remedial measures were given.

This work was done to a very large extent either personally or under the direction of Doctor Franklin, and the work this season has been continued under his supervision. The following data are either new, or confirm the findings of the two previous years.

This species deposits its winter eggs only on perennials, and of perennials, as far as can be determined, only on the apple. One young nymph was found on the willow, and one on plum. In each case these trees were only fifty yards from apple trees, and the nymphs may have been blown to the former trees or carried on larger insects or on the feet of birds. It seems desirable, for the sake of convenience in following the records bearing upon the life history of this insect, to arrange our findings in chronological order, therefore:

June 4th to 10th. At the time when nymphs were found on the apple nymphs were also gathered from the elm, white oak, red oak, gooseberry, black birch, white birch, linden, and reared to adult condition. These were all found to be species other than *E. mali*. Currant bushes, box-elder, mountain ash, dogwood and other perennials were examined carefully during the first two weeks in June, but no nymphs or adults of any species were found. One nymph was found on willow June 11th, and two on plum June 7th. The one on willow and one of those on the plum were reared and proved to be *E. mali*. These have been referred to above, and their occurrence on these trees possibly accounted for.

As proof that no winter eggs are laid on herbaceous plants we cite the results of experiments in which such plants badly infested during the summer and fall of 1908, and still plainly showing the effects of attack, were brought into the insectary and kept in the cold room through the winter. Upon some of these plants living specimens were found as late as October 8th. No individuals, however, survived the winter, nor did nymphs emerge from the tissues in the spring of 1909.

June 4th. No adults on apple trees, but nymphs in all stages. Adults found on alfalfa adjoining apple orchard, but no nymphs, this being a further proof that this insect does not pass the winter in the egg stage on alfalfa. Sweeping this field from time to time resulted in securing the following collections of adults on the dates named: June 4th, 46; June 9th, 91; June 11th, 192; June 14th, 177. On the 12th and 13th there were heavy rains, which may account for the falling off from June 11th. June 21st, 268, one nymph first stage. This is the first appearance of summer broods on herbaceous plants according to our observations. The field which we had been using was then cut, and the following observations were made on a smaller field: June 25th, 275 adults and a few nymphs of the first stage.

July 9th. Nymphs on clover in large numbers, no nymphs on alfalfa.

August 24th. Raspberry leaves badly infested.

August 26th. No egg blisters on apple branches.

September 13th. Egg blisters present on apple trees near clover field in considerable numbers, so numerous that probably egg laying had begun several days previously, yet it would seem that ovipositing was still going on at that date, since these blisters were not so numerous as they were late in the previous fall when egg-laying was over with.

September 17th. Very few nymphs found on alfalfa and clover.

Number of Broods: May 21st eggs hatched in insectary from apple twigs collected by Franklin in the fall of 1908. Since the emergence of these nymphs from the egg blisters may have a possible bearing upon remedial measures, I may be pardoned for taking the time to describe the process. The nymphs emerge from the blisters through the opening made by oviposition, making this opening somewhat larger during the process. We found that if the weather was warm emergence was complete in a few minutes. In one case it took five minutes from the time the vertex of the head appeared until it got completely out of the blister. In another case it took over thirteen minutes. Young hoppers were observed still emerging from egg blisters in large numbers as late as May 26th, at which time the

flower buds on the apple trees were on the point of opening. These observations prove that there is now no question but that the egg blisters so carefully measured by Franklin last fall on the branches of the trees in the apple orchard were those of *E. mali*.

June 4th. First young of the second brood collected on alfalfa.

July 17th. Adults first appeared from the young of June 21st; possibly they were present a few days earlier, for experiments and observations of 1907 and 1908 both show there is an average of twenty-two days in the nymphal stages.

Some of these adults of the second brood were placed on selected box elder seedlings, free from any insect, in lamp chimney breeding cages, for two days. On July 31st the first young appeared. The egg stage at this season of the year varied from seven to thirteen days, nine and one-half days being the average. If we add twenty-two days to this date, the time of hatching the egg, we get August 22d, the date on which the first of the third generation became adult.

Winter egg blisters were not found until fairly late in September, therefore it would seem that these adults of the third brood lay eggs for a fourth summer generation. Further, the finding of nymphs nearly as late as November 1st, 1908, would also indicate a fourth brood or partial fourth brood in Minnesota.

Economic Work: Doctor Franklin conceived the idea of a hopper dozer to be carried along nursery rows by two men. This hopper dozer consisted of a frame of wood, covered with light canvas, the canvas being covered inside with either crude oil, or some sticky substance. Such a machine was constructed, having a padded cross bar in such a position as to jar the tree, the purpose being to cause the hoppers to fly off and come in contact with the oil or other substance on the inside of the canvas. We found, however, that this bar, which was to serve as a bumper, was too far forward, and caused the tree to bend forward and strike the tree ahead, frightening the leaf hoppers from that tree, and hence nearly nine tenths of the hoppers escaped. Learning from this year's experience we perhaps can remedy these defects, and try the same thing with certain modifications next year. The crude oil which we used was not satisfactory, but the tanglefoot we found to be excellent. We made an imperfect trial of lights, with negative results.

It has also occurred to us that in the spring of the year nursery trees might be sprayed with a resin compound, or some sticky substance in connection with some of the standard solutions used at this time of the year, so coating the branches with a material harmless to the tree and preventing the emergence of the nymphs.

Parasites: We have reared no parasites from *Empoasca mali.*

NOTES ON PAPAIPEMA NITELA AND P. CATAPHRACTA

PAPAIPEMA NITELA: Eggs of this species, figured on page 153 of our Twelfth Report, were laid about September 15th, 1908. A good many hatched on May 24th and 25th, 1909, the hatching being completed May 29th. In all about one hundred caterpillars emerged. They at once showed the leaf-mining habit by making galleries in the leaves of giant bur-elder seedlings, which happened to be in the cage where they hatched, completely riddling the leaves of these plants (see drawings and photos). The caterpillars in their earlier stages moved like Geometrids. On May 28th about eighty-four larvæ from this hatching, which had not had the opportunity to establish themselves in mines, were placed upon selected bur-elder seedlings. According to Doctor Franklin's notes this was done about 5.30 on the above date. At 8 a. m. the next day, May 29th, they had all made quite elaborate galleries in the leaves of these seedlings. On June 2d, after about four days of leaf mining, it was noted that they were working down toward the bases of the leaves, and some had entered the petioles. On June 4th many of the larvæ had bored into the stalks — the tallest plants at that time being about five inches high. On July 7th many of these plants had been killed by the borers, and the larvæ so deprived of their food plants had entered their second plants. At this date host plants No. 2 were about two feet high, and the galleries therein were about four inches long. On July 22d the larvæ were from one to one and a fourth inches long, and the galleries had increased much in extent.

In one plant two caterpillars were found, and in this one the entrance hole of the lower caterpillar was nine inches from the ground, and that of the upper, thirteen inches from the ground, the galleries in each case being above the entrance holes.

On August 17th about all the larvæ which we had reared from eggs had disappeared from the plants. A few of the galleries contained pupæ. Therefore, *P. nitela* larvæ may attack two plants in the course of its life, but evidently never more than two. The first moth reared in captivity from the above material, emerged August 24th (one week earlier than last year), and the last one October 1st. Two seasons' observations indicate that the pupal stage lasts, on an average, twenty-three days.

P. nitela was reared from the following food plants this season: Nicotiani, lamb's quarters, tomato, giant ragweed, cocklebur, peony,

burdock and giant bur-elder, the last plant being, for the two seasons during which this pest was under observation, the worst affected. On August 1st two larvæ of *P. nitela* were found in giant ragweed, with their entrance holes twenty-one inches above the ground, and three other larvæ on the same date were discovered with entrance holes six feet above the ground. On the same date twelve *nitela* larvæ were found in a single giant bur-elder three feet high. Some of these were in the stalk, and some in the branches. In every case the burrow ascended from the entrance hole. On September 3d many empty burrows were found (evidently of both *P. nitela* and *P. calaphracta*) in hemp and other plants, indicating that a large per cent of the larvæ enter the ground to pupate.

P. CATAPHRACTA: On July 14th these were first observed working on young box elders. From this date on they were found to be quite common until nearly August 23d, when the last found larvæ pupated in captivity. Pupation, however, began August 7th, which is about the same date it was observed last year. On August 13th the first moth in captivity emerged.

The food plants as observed in 1909 are as follows: Burdock, box elder, giant bur-elder, hollyhock, cosmos, peony, larkspur, dahlia, thistle, aster, ragweed, tiger lily. It was not found at all in either hemp or golden glow this year. In both 1908 and 1909 it was found most common in burdock. The highest entrance hole in any plant found this year was four feet and two inches from the ground. The burrows did not extend below the lowest hole in any case. I wish to state, however, that from personal observation I do not think it safe to say that they never burrow below the entrance hole, since I believe I have sometimes found the galleries in this position.

Observations on the Migrations of the Larvae in Search of Food Plants: As shown above, the larvæ of one of these species, and probably both, may infest two food plants, and experiments were carried on with a number of nearly or quite full grown larvæ to observe their movements in seeking food. Larvæ were placed in various locations in our experiment garden, and their movements watched for several hours, frequently until they stopped apparently exhausted and finally died without being allowed to enter any food plant. It would seem from these observations, in which we marked carefully the course of each larva, that they seldom if ever travel any considerable distance in a straight line from the place where they first hatch. The caterpillar making the best record in actual distance traveled in all seventy-nine feet before stopping from exhaustion, but this course was so irregular and tortuous that when it finished

it was only fourteen feet in actual distance from the starting point. Another larva traveled a distance of fifty-six feet before becoming exhausted and at that time was only sixteen and one-half feet from its starting point; a third traveled a total distance of fifty-five feet, and ended twenty-four feet from the starting point, this being the farthest distance reached from the starting point of which we have record. These larvæ were all practically full grown. Occasionally ants appeared to attack the larvæ and cause considerable annoyance.

Plants, the lower part of whose stems were covered with tanglefoot, were completely exempt from injury. It was repeatedly observed in these experiments that when a larva got within a foot or two of a food plant, it had to be constantly turned away from it, since it showed great determination to reach the stems of the desired plant. The two charts shown illustrate the devious routes of two of these larvæ. In one it will be noted that a fairly straight course was taken through plot 46, filled with tomatoes. This was undoubtedly brought about by the fact that although it sought to enter the tomatoes, it was kept away from them constantly, hence the somewhat straight course through that plot. Each plot as shown was four feet square, and the space between the plots was four feet.

The parks about Minneapolis and St. Paul are kept remarkably clean and free from weeds, and several days spent in examining flower beds in these parks resulted in finding that they were almost entirely free from the attacks of stalk borers. When these pests were present they were always found in beds located in a neglected corner of the park near some weedy patch, it being evident in these cases that the larvæ came from the weeds.

Economic Suggestions and Experiments: It is very evident that where flower gardens and their environment can be kept perfectly free from weeds, freedom from attacks of this pest is assured. From our own observation it is clear that it is very desirable to clear up weeds that start during the latter part of May and during June in such places, because at that time any young larvæ which may be mining the leaves of the weeds, will be destroyed with the weeds. Further, it is not probable, from what we have seen in our own experimental garden, that these pests make extensive migrations to other plants. Occasions arise, however, when an owner of a garden cannot control adjoining ground, which may be weedy, in which case it is necessary to find some means of keeping the larvæ out of the garden entirely. Without going into details of the experiments which we have tried this last summer, experiments which called for the planting of very

many plots similar to what are shown on these charts, using such food plants as hemp, peony, dahlia, corn, potatoes, tomatoes, golden glow, asters, tiger lilies, hollyhocks, giant bur-elder, giant ragweed, burdock, daisies, sunflowers, etc., we may say briefly that the most effective barrier found was a thin board smeared with tanglefoot on the outside. This board was about one eighth of an inch thick, and about five inches wide, and placed in the ground edgewise, around the four sides of the plot. The tanglefoot should be put on an inch or so above the ground, so that it could not be easily coated with earth by the spattering occasioned in the event of heavy showers; and whatever sticky substance is used, it should be of such a nature as to either remain sticky, or be kept sticky by several applications, from June 1st to August 1st.

The fact that the larvæ show a strong tendency, when within about two feet of their favorite food plants, to go to said food plants directly, suggests that possibly a barrier of weeds might be placed around a garden, thus providing the caterpillars hatched outside the garden with food, and making it unnecessary for them to travel to the flower beds. These would have to be burned in the fall, of course. They would have to be in position during the last of May, or early part of June.

Parasites: These two species appear to be extensively parasitized, since we have reared many individuals of Tachinids from them. From *P. cataphracta*, *Hypostena variabilis* Coq., and from *P. nitela* also an *Exorista* sp. also *Masicera myoidæa* Desv. in large numbers, the last named being identified by Professor Aldrich. From a breeding cage containing both species we reared what I regard as *Ichneumon lætus*, and evidently *Ichneumon orpheus* Cress. From some material emerging from the pupa of *P. nitela* Professor Aldrich also named for us an Ortalid, *Chætopsis aenæa* Wied.

We have considerably more parasitic material from these two species of at least one genus and parasitic.

MR. SANDERSON: I would like to inquire if the leaf hopper causes serious damage to old apple trees? Does the work of this insect affect the growth of old trees seriously?

MR. BRUES: In regard to the Ortalids, it is well known that the species of at least one genus are parasitic.

MR. SANDERSON: The reason I asked these questions was because some trees in New Hampshire have suffered in the past season from the attack of leaf hoppers.

MR. FELT: I do not know what the conditions are in New Hampshire. Some injury has resulted in New York State, but upon submitting specimens to Mr. Van Duzee they were determined as *Typhlocyba rosæ* Linn.

PRESIDENT BRITTON: The next paper on the programme will be read by Mr. A. G. Hammar, Washington, D. C., entitled "Methods Used in Rearing the Grape Root-Worm (*Fidia viticida* Walsh) and the Codling Moth."

METHODS IN REARING THE GRAPE ROOT-WORM, FIDIA VITICIDA WALSH, AND THE CODLING MOTH, CARPOCAPSA POMONELLA L.

By A. G. HAMMAR, *Bureau of Entomology, North East, Pa., Field Station*

This paper was accompanied by lantern slides showing breeding cages and other devices used in the rearing of the insects, with a summary account of the results obtained with the Grape Root-worm.

[Withdrawn for publication elsewhere.]

PRESIDENT BRITTON: The next paper on the programme will be presented by Mr. W. C. O'Kane, Durham, N. H., entitled "Work on the Apple Maggot."

WORK ON THE APPLE MAGGOT

By W. C. O'KANE, *Durham, N. H.*

In New Hampshire today the most serious orchard pest is the Apple Maggot, *Rhagoletis pomonella,* Walsh.

Four factors contribute to this:

1. The apple is a principal crop in New Hampshire.

2. The infestation is now general throughout the lower two thirds of the state, including the entire apple growing section.

3. While formerly found in early or sweet varieties, usually grown for home use, the insect is now spreading rapidly to the winter fruit, which is the commercial mainstay of the orchardist.

4. No positive, effective and practical remedy is known; at least, none that we may recommend with certainty to the grower who happens to have a careless neighbor, that does not keep his fallen fruit picked up, or to the man whose trees may lie partly along a

stone wall where drops are sure to lodge undetected. Incidentally most orchards in New Hampshire are provided with such walls, varying in thickness from eighteen inches to five feet.

Twenty years ago Professor Harvey in Maine published his monograph of the Apple Maggot. It was a good piece of work. The anatomy and histology of the insect were worked out; the fact was discovered and proved that the egg is inserted beneath the skin of the apple, not laid on the surface; matters of consequence in the life history were determined; and remedial measures were suggested.

Since then Rhode Island has done some work, and the subject has been touched on elsewhere.

No investigation in entomology is ever complete. Matters unthought of, or untouched because they seemed trivial, turn out to be important. The Apple Maggot is no exception. There are gaps in our knowledge of the insect. And it remains still a half-solved problem, which means that, economically, it is not solved at all.

We have undertaken to fill these gaps, so far as we can; and to find the remedy, if it lies in our power to discover it.

To trace the spread of the insect in the state, and to get at certain economic phases of the problem, we are securing from the growers detailed reports of the conditions in their orchards. We furnish them with two printed blanks. One contains a list of seventy-two varieties of apples, and we ask them to indicate those that are badly infested, those moderately infested and those free from attack. The other contains numerous questions. We ask them what their loss has been this year; how long their trees have been infested; how their trees are situated — whether in sod, cultivation or pasture, whether any lie along a stone wall. We want to know if they have ever allowed any sheep in their orchard, any pigs, any chickens, any cows, and — what is equally to the point — what time of year were they turned into the orchard and when removed. We ask them if they keep the fallen fruit picked up, and — again an important point — how often. Other similar questions are included in this blank.

These reports are coming in rapidly, and are both interesting and valuable. Some of the data may be crude and some unreliable, but much is to the point and all is suggestive.

In the matter of life history and habits we are giving particular attention to some eight or ten problems, all of them now more or less obscure. We want to know what becomes of the larvæ in winter apples — for they are there, half grown, as late as December. A lot of these apples are now under observation. Records have been made in various orchards that will form the basis for a study of the flying

powers or wandering habits of the adult female — in other words, the possible danger zone of an infested tree. Later we hope to determine the time that elapses after the female emerges before it is ready to lay eggs, and the feeding habits during this period. This fall we have started on a study of the depth to which the larvæ go to pupate, under various conditions, and the time that elapses after the larva issues from the fruit until it begins to pupate.

Most winter apples in New Hampshire are kept for a while in storage of one kind or another, either in a fruit cellar or under refrigeration. We have secured infested and non-infested apples of the same variety, from the same orchard, and of as nearly identical quality as possible. We have placed these in storage, to observe the deterioration of the one as compared with the other, both during and after storage, and the effect on the vitality and development of the larvæ.

Apparently, in orchards of a hard, winter variety, such trees as are infested will show fruit ripening a little in advance of the rest. We have set ourselves to find out whether this fruit ripens prematurely because of the presence of the larvæ in it, or whether certain trees with a trifle earlier bearing proclivities offer fruit more attractive to the egg laying female. By means of limb cages, and controlled infestation, we hope to accomplish this.

Data are in shape, and plans are now being made, for a thoro tryout of methods of control, on a sufficiently large scale to be conclusive. These will include cultural methods, such as deep plowing; repeated, shallow cultivation; removal of fallen fruit; and the use of livestock, especially hogs, sheep and chickens.

Another plan that will have a thoro trying-out is the use of sweetened arsenicals to poison the adult prior to the beginning of egg laying. The success achieved by Mr. Mally in South Africa this last season, in adapting this remedy to the Fruit Fly, *Ceratitis capitata*, Wied., leads us to hope for good results here. The insects are not the same at all, but their habits are similar.

Finally, in a biological way this insect presents an interesting question of *possible races within a species.* It is a fact that we may have early, infested fruit close to late fruit, with the latter free from attack. Equally is it true that in other cases the late fruit is badly infested. The question then arises: Whether within this species there may not be definite racial limits corresponding to the widely divergent characteristics of early summer apples and of late winter fruit; these limits defined by the inability of a race maturing normally in the one to adapt itself in the next generation to the variety inhabited

by the other race, altho these two races show no structural differences. By isolating fruit with limb cages and making use of artificial infestation we hope to get some interesting lights on this problem. It is of immediate practical value because it means danger or no danger from infested wayside or farmyard trees lying near commercial orchards.

Probably the foregoing will keep us rather well occupied and doubtless other phases will turn up later.

Some of the members of this association have had experience in working out a problem of this type. We should be very glad to receive from these any suggestions as to what to do and what not to do in our work.

MR. BRAUCHER: What is the best method of protecting fruit from this insect, and how can you tell whether the fruit is infested? My experience has been that there is not much indication of infestation on the outside of the fruit.

MR. O'KANE: In the case of certain varieties of apple, it is sometimes difficult to determine whether or not fruit is infested with this insect, although it is always possible to do so by critically examining it with a hand lens.

PRESIDENT BRITTON: Doctor Felt will now present his paper, entitled "Spraying for the Codling Moth."

SPRAYING FOR THE CODLING MOTH

By E. P. FELT, *Albany, N. Y.*

The main purpose of our experiments was to test the relative efficiency of a coarse driving spray, such as that produced by a typical Bordeaux nozzle with a pressure of over 100 pounds, in comparison with the fine misty spray of the Vermorel nozzle and its various modifications.

Comparisons were made between single sprays of each of the above mentioned kinds, applied just after the blossoms fell (plots 1 and 4), between two sprays of each kind, one given just after the blossoms fell and the second just before the sepals closed (plots 2 and 5), and finally between two such sprays and a third applied with a Friend nozzle the last week in July, for the purpose of destroying the second brood of the codling moth (plots 3 and 6).

These experiments were conducted in a young orchard belonging to Mr. W. H. Hart of Arlington, N. Y., near Poughkeepsie, the first

being duplicated in the orchard of Edward VanAlstyne at Kinderhook. The Hart orchard is on a moderately high hill, the trees being thrifty, about fifteen years old, 15 to 18 feet high and 30 feet apart. Each plot consisted of approximately forty-two trees, six trees in a row one way and seven in a row the other way, the central six being the actual experimental trees and invariably Baldwins, though some of the barrier trees were Northern Spys. The experimental trees were carefully selected for uniformity of size, fruitage and infestation. An examination of one resulted in finding thirteen empty codling moth cells and of another, none. These were not in the experimental area. The orchard as a whole had not been sprayed much prior to the past season.

The spraying followed the usual practice of orchardists, the aim being to cover the entire tree and especially to hit the tips of the young apples with the spray. The Bordeaux nozzles were set so as to give a maximum of rather coarse spray which would not break up into fine drops till about six feet from the nozzle. The aim of this application was to drive the poison straight down into the tip of every young apple, the nozzle being held about 18 to 24 inches from the fruit so far as possible, and the pressure being maintained at about 150 pounds. This gave a stiff, penetrating spray which repeatedly passed the stamens and collected in the lower cavity, especially in the first application. Despite the above, it was found practically impossible to fill the lower calyx cavity in all cases, especially was this true during the second spraying after the stamen bars had withered a little. An examination showed that the dried tips of these organs were very likely to become entangled and present a most effective barrier to the passage of the spray. In practice it was found much more difficult to cover a tree thoroughly with the Bordeaux type of nozzle than it was with the much broader and more evenly distributed spray coming from the Vermorel nozzle.

The trees were sprayed with 5¼ pounds of Grasselli's arsenate of lead and 10 pounds of copper sulfate to each 150 gallons of spray, enough lime being added to neutralize the copper sulfate as determined by the Ferro-cyanide test. The first application was made May 20, the second May 31 and the third June 28. Two check trees were left in the immediate vicinity of the experimental plots.

Observations upon the growth and development of the fruit were made at intervals during the season, and on September 13 and 14 the dropped apples were collected and carefully sorted. It was then found that there were from 14.91 per cent to 26.67 per cent of wormy fruit under the experimental trees, while the check trees had 73.91

and 81.02 per cent. respectively, of wormy fruit. The apples were picked October 5 to 7 and the remaining windfalls and all on the trees carefully sorted, and these figures, combined with those obtained earlier in the season, were brought together in the following table.

SUMMARY OF PLOTS

Plot.	Total No. of Fruit.	Clean Fruit.		Wormy Fruit.			
		No.	Per cent.	No.	Per cent.	Range of per cent between trees.	Range in No. between trees.
1.....	30,177	29,818	98.81	359	1.19	.63- 3.16	30-111
2.....	10,316	10,206	98.93	110	1.07	.61- 2.66	6- 30
3.....	9,680	9,582	98.99	98	1.01	.32- 2.64	4- 29
4.....	20,313	20,017	98.55	296	1.45	.96- 2.64	36- 89
5.	19,275	19,084	99.01	191	.99	.49- 1.51	15- 61
6.... ..	7,710	7,633	99.	77	1.	.59- 2.74	4- 23
Check.	3,251	2,366	72.73	885	27.27	25.71-33.57	217 668

Bearing in mind that plots 1 to 3 were sprayed with Vermorel nozzles and 4 to 6 with Bordeaux nozzles, as described above, it will be seen that in each of these groups there is a successive decrease in the number of wormy fruit obtained from the various plots. This, while apparently significant, has no bearing upon the problem, since there is a similar decrease in the total number of fruit upon the trees of the various plots. The percentages of clean fruit or the percentages of wormy fruit, it will be seen, are remarkably uniform for each of the six plots, showing that so far as this orchard is concerned under conditions obtaining the past season, there was very little difference between treatment with a coarse driving spray applied at a relatively high pressure and a finer spray which under no conditions could be driven with much force. Furthermore, it is impossible from a study of the percentages, to find any very marked benefit from the second and third applications unless it be in the case of the treatments with the Bordeaux nozzle. Even then the latter only approximate and hardly exceed the results obtained with the Vermorel nozzle. As pointed out before, it was found much more difficult to cover a tree thoroughly with the Bordeaux than with the Vermorel nozzle. Reference to the check trees shows a material benefit accruing from even one application, since the sprayed plots gave at least 98.55 per cent of worm free fruit, while the unsprayed or check trees produced but 72.73 per cent of worm free fruit.

An analysis of the records of individual trees in the various plots summarized in the following table, discloses an interesting condition.

VARIATION IN INDIVIDUAL TREES

Plot.	Maximum Tree.		Minimum Tree.		Range in No. of Wormy Fruit.
	No. Fruit.	Per cent Wormy.	No. Fruit.	Per cent Wormy.	
1	8,745	.63	2,507	3.16	30-111
2	3,649	.75	226	2.66	6- 30
3	2,298	.61	417	2.64	4- 29
4	5,044	.96	3,002	2.64	36- 80
5	5,137	.49	994	1.50	15- 61
6	3,821	.70	767	2.74	4- 23

The maximum tree of a plot invariably produced the lowest or nearly the lowest percentage of wormy fruit, while the reverse was true of the minimum tree. It will be seen that the variation in number of wormy apples on the various trees was not very great, indicating a fairly uniform degree of infestation. Were such to be true we would expect a lower percentage, as shown by the figures for wormy fruit, on the heavily laden trees. A reference to the record of the plots as a whole shows practically no variation in the percentages of wormy fruit between the more and the less productive plots. This may be due in part to the fact that the plots sprayed two and three times yielded less fruit than those receiving one application of poison —the smaller yield offsetting in a measure the benefit derived from the second and third sprayings.

It may be inferred from the above that unusually favoring conditions resulted in this somewhat anomalous showing. The first experiment, that is, a single application with the Bordeaux and the Vermorel nozzles was also tried at Kinderhook under different conditions, since the trees were older and, moreover, were in the vicinity of still older trees. There is every reason for believing that the codling moth was more abundant in this latter orchard than in the first named. Two plots were laid out in the same manner as at Poughkeepsie and thoroughly sprayed. One plot gave an average of 98.96 per cent of worm free fruit and the other of 98.27, while the check trees produced but 73.08 per cent of worm free fruit. Owing to there being no engine available for these latter experiments and the difficulty of maintaining a suitable pressure by hand, the

spraying was not as thorough as that at Poughkeepsie. The result is shown in a slight lowering in the percentage of perfect fruit.

A study of the wormy fruit gives some interesting data, since it was found on plots 1 to 3, that 10% to 18.36% of all the wormy apples were entered at the end, an average of 14% end wormy. Similarly, in the case of plots 4 to 6, the variation was from 9.94% to 12.50% or an average of 11.50% of end wormy apples in the total infested. Comparing these percentages with the 69.37% end wormy of the infested apples on the two check trees, it will be seen that the major proportion of the codling moth larvæ destroyed, must have been killed in or about the blossom end because of the enormous reduction in the sprayed fruit of the number of end wormy apples. There is a slight percentage in this respect in favor of the coarse spray with the Bordeaux nozzles. Duplicate experiments in another orchard at Kinderhook gave 17.51% to 18.9% end wormy fruit on the sprayed trees, while on the check trees there were 37.28% end wormy fruit. It is evident from the above that the spraying results in the marked reduction in the percentage of end wormy fruit, and that this benefit is secured in large measure at least, without regard to the amount of poison driven into the lower calyx cavity.

The results given above would seem to justify, so far as the Hudson River is concerned, the belief that one thorough spraying with a Vermorel nozzle within a week or ten days after the blossoms fall, will result in protecting a very large percentage of the fruit from codling moth injury.

MR. RUMSEY: I have a set of photographs with me showing the final results of a test we made at the West Virginia Agricultural Experiment Station to determine the relative merits of a mist spray and a coarse, high pressure spray for the codling moth. Before passing the pictures I will give some details of the experiment. Fifty-three Ben Davis trees were used in the work. Twenty-four trees were sprayed four times with three pounds of arsenate of lead to fifty gallons of Bordeaux, using a "Vermorel" nozzle with a pressure of about one hundred pounds. The same number of trees were sprayed once with one pound of arsenate of lead to fifty gallons of water, using a "Bordeaux" nozzle, connected to the spray rod by an attachment bent at an angle of 45°, with a pressure of two hundred to two hundred and fifty pounds. The spray was applied just after the petals fell. To the trees which received four sprayings the last spray was applied July 21. Five trees of the same variety were reserved

as checks. Five trees were also selected from each of the different methods of treatment. The fruit from the fifteen trees was examined about every two weeks during the season, beginning with the June drop. A record was made of the wormy apples as to whether the worms entered at the calyx, side or stem of the fruit. While the test was made primarily against the codling moth a record was also kept of the curculio marked apples.

The percentages marked on the photographs are simply those obtained from the picked fruit as seen in the pictures. When we take into consideration the dropped apples from the check trees, the per cent of wormy and curculio marked fruit will be increased as it may also be in the sprayed trees. The average per cent of wormy and curculio marked fruit as seen in the pictures is as follows:

Check trees: per cent wormy, 36; per cent curculio marked, 34.

Mist spray: per cent wormy, 3; per cent curculio marked, 11.

Coarse spray (high pressure): per cent wormy, 2; per cent curculio marked, 11.

MR. SANDERSON: Doctor Felt's results correspond exactly with what I have secured in New Hampshire.

I would like to know what results he got from the use of the Friend nozzle. I wish there was some way of using the word "Vermorel," as applied to the different forms of nozzles, without using the one name. I think we had better refer it to the Committee on Nomenclature, and get a name for the special kinds. It has been suggested that this form of nozzles be called the "Disc" type, which term seems worthy of adoption.

My experience has been that the Friend is superior to the old nozzle. As regards the driving spray: I do believe that the driving spray is superior in that you can get the spray into the tree, and get the fruit treated, which you cannot do with a mist spray.

MR. FELT: I have the very highest respect for Professor Sanderson's opinions, but I must take a diametrically opposite position. I must say, from my observations, that you will have great difficulty in covering the trees thoroughly with a driving spray.

MR. BRAUCHER: The first season that I used the Bordeaux nozzle my experience was the same as Doctor Felt's; I was unable to cover the trees thoroughly when using a single nozzle. By using two nozzles the past season with a Y and a 45° crook, having the nozzles set so the two fan-shaped sprays were parallel to each other and to the horizon and at right angle to the extension rod I was able to do very

satisfactory work. When the nozzles are properly set and the coarse spray is used the fans meet about four or five feet from the nozzles and at 200 pounds pressure give a fine driving spray that can be directed downward into the calyx cups and do very satisfactory work.

SECRETARY BURGESS: I would suggest to the members that after they see the spraying demonstration tomorrow, they try an adaptation of the solid stream spray, as I believe it is the coming system for treating apple orchards.

PRESIDENT BRITTON: The next paper will be read by Prof. R. A. Cooley, Bozeman, Mont., entitled "Notes on the Ten-Lined Potato Beetle in Montana."

NOTES ON THE TEN-LINED POTATO BEETLE IN MONTANA

By R. A. COOLEY, *Montana Agricultural College*

During the summer of 1907 and again in 1908 frequent observations were made on the life history of the ten-lined potato beetle in a small patch of potatoes in the home garden at Bozeman, Montana, and the writer became convinced that only one brood of larvæ was produced. The principal points in the life history were followed during both seasons, including the first appearance of the adults, the eggs on potato and on closely related wild plants, the development of the larvæ, their disappearance for pupation and the subsequent appearance of fresh adults. In both seasons the adults disappeared without depositing eggs for a second generation.

It seemed desirable, however, to make cage experiments, and accordingly adults were taken into the insectary on June 19, 1908. Our notes for this season show that the first adult was observed on June 2. On June 7 adults were becoming plentiful and were seen on potatoes in the garden, and on June 13 eggs were being laid plentifully. The beetles taken on June 19 were then clearly of the over-wintered brood. These beetles in the cages laid eggs promptly and plentifully. The first eggs hatched in thirteen days and the larvæ went into the earth on July 13. The first adults appeared on July 30, and after feeding for a few days disappeared into the earth on August 13.

Most of the over-wintered females died after laying a few clusters of eggs, but one individual continued to lay at frequent intervals

up to September 1, when no further attention was given to the cage. This female was alive and laying eggs nineteen days after adults reared from her eggs had gone into the earth for the winter. This female would eat her own eggs when food became scarce, and the larvæ would eat eggs at any time. Observations out of doors carried on during three years show that the beetles had practically all gone into the earth for the winter by August 27. The non-appearance of a second brood of larvæ in Bozeman has thus been noted three years in succession. The elevation of Bozeman in the Gallatin Valley is 4,800 feet; the latitude is about 46°.

We have not made definite observations on the number of generations per year in other parts of Montana, but it seems probable that in the lower valleys of the state where the growing season is longer, the usual two broods will occur.

This beetle is still spreading into new territory in Montana. It has been introduced into Flathead County only during the last few years. Its first appearance in other valleys in the state is still fresh in the memory of residents. On the testimony of early residents it is clearly an introduced species in the Gallatin Valley which is east of the main divide of the Rocky Mountains.

In the Gallatin Valley the species thrives in a wild state on *Solanum triflorum*, which is an abundant weed in unplowed fields. The adults migrate into potato fields from the surrounding native vegetation in great numbers, and in one brood constitute a serious pest.

PRESIDENT BRITTON: I wish to state at this time that it was impossible for Doctor Howard to be present at the meeting, in order to tell us about the parasite work which is being carried on in Massachusetts. The introduction of the parasites and natural enemies of the Gipsy and Brown-Tail Moths is one of the largest experiments of the kind ever attempted. Doctor Howard, however, has authorized Mr. Fiske to make a statement in relation to the progress of the work, and we will now be glad to hear from him.

WORK WITH PARASITES OF THE GIPSY AND BROWN-TAIL MOTHS

By W. F. FISKE, *Bureau of Entomology*

[Withdrawn for publication elsewhere]

PRESIDENT BRITTON: Mr. John J. Davis, Urbana, Ill., will now present his paper, entitled: "Insect Notes from Illinois for 1909."

INSECT NOTES FROM ILLINOIS FOR 1909

By JOHN J. DAVIS, *Office of the State Entomologist, Urbana, Ill.*

The following notes are taken from observations by the writer, and, unless otherwise indicated, were made in and about Chicago.

Insects of the Truck Farm and Vegetable Garden

The common asparagus-beetle (*Crioceris asparagi* Linn.) is not very widely distributed, for it is known to occur only in a comparatively small area northwest of the city. Where found, however, it is a pest of great importance every year.

The imported cabbage-worm (*Pontia rapæ* Sch.) was not so generally destructive as in previous years, but in restricted localities, and also in the west-central part of the state, the crop was a total failure because of it.

The cabbage-maggot (*Pegomyia brassicæ* Bouché) is annually a pest of greatest importance; in fact, the growing of early cabbage and cauliflower has been almost entirely discontinued because of it. Midsummer and late cabbage is seldom noticeably injured, nor are the cabbage plants often injured in the seed-bed. Many of the remedies which have been proposed by writers were tried, and only two gave favorable results, these being the tarred felt cards and hellebore decoction, the latter proving the more satisfactory. Applications of commercial fertilizer are of much value.

The cabbage-aphis (*Aphis brassicæ* Linn.) was not so generally destructive this year as in previous years, when it has ruined large acreages of cabbages.

The striped cucumber-beetle (*Diabrotica vittata* Fab.) is seldom a very important pest, and when present it is usually readily controlled by the use of some simple repellant, such as air-slacked lime, dust, land plaster, etc. This year no appreciable injury was done by this insect.

The melon-aphis (*Aphis gossypii* Glov.) has never been destructive to cucurbits out-of-doors in the vicinity of Chicago, but in west-central Illinois it is usually one of the most important considerations in the growing of melons. This year, however, it was much less common than in former years. Greenhouse cucumbers, an important product, are often badly injured by the melon-aphis, but where fumigation

with hydrocyanic acid gas or tobacco is practiced, it seldom becomes troublesome.

The squash-bug (*Anasa tristis* DeG.) was found destructive in a few isolated localities, and in every instance the injured vines were near an out-building or other desirable hibernating quarters. More often the injury was to young cucumber plants in cold frames.

The fickle midge (*Sciara inconstans* Fitch) is one of the most destructive hothouse cucumber pests in northern Illinois. The maggots attack the roots and stem of the plant, gnawing the tissue and eating into it. Affected plants may be recognized by a characteristic wilting, and by their slow growth, and unless treated they will soon die. Never have I found appreciable injury except where fresh manure was used. The susceptibility of various varieties is well shown in the photographs. Two varieties, Davis Perfect and a common white spine, were grown in the same range, the cultivation, planting, manuring, etc., being identical. The Davis Perfect, a cross between a white spine and English, was scarcely injured, and had large healthy foliage, while the common white spine was practically ruined. The use of a soaponified creosote preparation, applied at the base of the plant, proved of value, but further experiments should be made with it before it can be recommended as a certain remedy. Nicotine extract and "lemon oil" also proved beneficial. The use of old rather than fresh manure is certainly most commendable.

The greenhouse white-fly (*Aleurodes vaporariorum* West.) and the red spider (*Tetranychus bimaculatus* Harv.) are always pests of cucumbers under glass in this state. As is well known, the former can be controlled by the proper use of hydrocyanic acid gas, but the red spider, after once getting a good start, is not so easily dealt with. Nothing that we have tried has proven satisfactory.

Horse-radish was injured in certain localities by the horse-radish flea-beetle (*Phyllotreta armoraciæ* Koch[1]).

Greenhouse lettuce was badly attacked by the variegated cutworm (*Peridroma saucia* Hbn.), and the European lettuce plant-louse (*Macrosiphum lactucæ* Kalt.?). By poisoning the lettuce leaves and laying them on the bed before setting out the plants, injury by the cutworms was, in most cases, prevented. The plant-lice were easily controlled by the use of tobacco or hydrocyanic acid gas fumigation.

The onion-maggot (*Phorbia cepetorum* Meade), although doing much injury in several places, was not nearly so numerous as in years previous.

[1] Determined by C. A. Hart.

About mid-August, the onion thrips (*Thrips tabaci* Lind.) was very abundant, and did much damage to onions, and especially to the onions for seed. They attacked the seed-pods before the seeds had hardened, and in many places the seed crop was a total failure.

The Colorado potato-beetle (*Leptinotarsa decemlineata* Say) was about as abundant as usual. The apple leaf-hopper (*Empoasca mali* LeB.), which was very destructive to potatoes last year, was a slight offender in 1909.

A new pest of the potato and other crops for this part of the state has made its appearance within the last few years, and this year it has spread over a much larger territory, and has become a pest of prime importance. This insect is one of the wireworms (*Limonius confusus* Lec.[1]), and, according to our observations in Cook County, differs from most wireworms in that it is most abundant and destructive in the higher parts of the infested areas. This species was found damaging potatoes, tomatoes, onions, cabbages, radishes, and sweet-corn. The English soil-fumigant, Apterite, which has been highly recommended by one or two English entomologists, was tried, but without any noticeable benefit.

Insects Injurious to Flowering Plants

The corn root-aphis (*Aphis maidi-radicis* Forbes) was not nearly so destructive to asters as last year, but, nevertheless, injury was reported from a few localities.

In greenhouses, aphids were not especially abundant, except in a few cases. Those which were found doing noticeable damage were *Myzus persicæ* Sulz. on carnations, *Macrosiphum circumflexa* Buck. on easter lily and maidenhair ferns, and *M. sanborni* Gill. and *Aphis rufomaculata* Will. on chrysanthemum.

The variegated cutworm (*Peridroma saucia* Hbn.) was found damaging greenhouse carnations, smilax, and *Asparagus plumosa*. It is especially fond of the tender young asparagus shoots. Our experiments showed the poisoned bran mixture together with the trap lantern a very satisfactory remedy. Hand picking was useless in the asparagus houses.

The greenhouse leaf-tyer (*Phlyctænia ferrugalis* Hbn.) is another greenhouse insect which is with us every year, attacking chrysanthemums. It is of no importance on any other plant. The use of arsenate of lead, beginning when the plants are small, has given us satisfactory results.

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[1] Determined by C. A. Hart.

cucumbers showing susceptibility to Sciara attack. On the right is the common, white spined variety and on the left Davis perfect

A, perfect cucumbers showing relative immunity from Sciara attack. Grown in same range as those illustrated on Plate 11

Common, white, spined cucumbers showing injury by Sciara and grown in the same range as those illustrated on Plate 10. Sciara was very abundant in these houses

The southern fern cutworm (*Callopistria floridensis* Guen.) is an insect which has only recently made its appearance as a destructive pest of greenhouse ferns, especially the Boston ferns. It was first reported from Onarga, Ill., in 1907, and since then it has required strict vigilance on the part of the Onarga florist and two other florists in Chicago to keep it from destroying their entire stock. Although only known to occur in these three greenhouses, in Illinois, it is a pest of much importance where found. This species was described in 1852 by Guenée from a single male collected in Florida, and, so far as we have been able to learn, it was not reported again until this year in the Yearbook of the U. S. Department of Agriculture for 1908, where the Bureau of Entomology reports it as a destructive insect on ferns in Washington, D. C., greenhouses. Our experiments show the use of pyrethrum spray late in the afternoon or in the evening, together with the trap lantern, to be the best means of combating them.

The onion thrips (*Thrips tabaci* Lind.) is the most generally destructive pest known to the Illinois florist, roses and carnations being seriously damaged. They are abundant every year, and especially so during the early and late summer months. Nicotine extracts are the most generally used and have given the best satisfaction. Clean cultivation in and around the green houses is of much value. Our experiments show the thrips to be most active on the outside of the buds early in the morning, consequently spraying or fumigating at that time of day is desirable.

The greenhouse thrips (*Heliothrips hæmorrhoidalis* Bouché) is only occasionally injurious. The past year it has been found damaging the Norfolk pine, smilax, and calla lily.

Annually for the past ten or twelve years the rose-midge (*Neocerata rhodophaga* Coq.) has been the cause of thousands of dollars loss to several Chicago rose growers. This insect is not so prevalent now as in former years, because most of the florists who were at one time troubled with it have either discontinued growing roses or have changed the crops grown in previously-infested ranges. In other words, those florists who are now troubled with this pest have been growing roses continuously in those houses originally infested or in nearby houses. Where this species occurs it is the most destructive greenhouse pest known. Hydrocyanic acid gas was thoroughly tried, but it was ineffective against the maggots at a strength which would not kill the plants.

The cabbage plutella (*Plutella maculipennis* Curt.) has made its

appearance as a serious greenhouse pest, attacking stock and sweet alyssum.

Another unusual greenhouse insect, which has recently appeared, is the garden flea-hopper (*Halticus uhleri* Giard). It attacks smilax, the only greenhouse plant found to be appreciably damaged.

An interesting cercopid (*Philænus spumarius*[1]) was found very abundant on greenhouse rose stock which had recently been imported from Europe. Inasmuch as this species had never been noticed before by us, it is probable that it was imported with the stock. The white frothy masses produced by the nymphs were very conspicuous on the immature rose buds and in the crotches of the more tender branches.

Insects Injuring Shade Trees and Ornamental Shrubs

The bronze birch-borer (*Agrilus anxius* Gory) is found throughout the parks of Chicago, and is doing much damage to the birch trees. It has also been especially destructive in several of the nurseries.

The imported poplar and willow curculio (*Cryptorhynchus lapathi* L.) was first found, several years ago, in the south part of the city. We now have records of the occurrence of this insect in all parts of the city and in several nearby nurseries, where it has been introduced on stock from nurseries in the east. It is a serious pest at present — the most destructive of the many poplar insects — and is continually spreading.

What is supposed to be the linden borer (*Saperda vestita* Say) was found this fall doing much damage in one of the large cemeteries. Only the European lindens were attacked, but all of these, both the permanent plantings and the nursery stock, were dying or dead from its work. Adults have not yet been bred and the identity of the species is uncertain.

The cornus borer (*Oberea tripunctata* Fab.) is found infesting much of the dogwood plantings in the park systems. From a large number of larvæ examined last spring 44 per cent were found parasitized with an ichneumonid.

Ranking in importance with the birch and poplar borers is an undetermined ninebark sesiid borer[2] which has proven to be an important pest of ninebark, *Physocarpus opuli-folius*, this shrub being one which is commonly planted in the Chicago parks. The borer usually

[1] Determined by Mr. C. A. Hart.

[2] Since writing the above Mr. C. A. Hart has determined those bred from ninebark and Cornus as *Sesia scitula* Harr. and those from Viburnum as *Sesia pictipes* G. and R.

infests the lower parts of the branches, but in some cases, especially in large branches, they may be found three or four feet above the ground. They burrow in the sapwood, often completely girdling the branch. The same species has been bred by us the past year, from *Cornus* and *Viburnum*.

A leaf-roller (*Exartema permundanum* Clem.) did much damage to *Physocarpus opulifolius* in some of the parks. It hibernates as a larva in folded leaves, and is found in destructive numbers only in those places where the leaves are not raked up and destroyed.

A second leaf-roller (*Olethreutes hemidesma* Zell.[1]) was found quite abundant in some of the nurseries attacking *Spiræa vanhuttei*. The first brood did the most damage, a large per cent of the second brood being parasitized.

Another insect which was conspicuous as an enemy to *Spiræa vanhuttei* is the spiræe sawfly (*Pristiphora birittata* Nort.[1]) It was common in several nurseries, and in one of them a large acreage of *Spiræa* was kept completely defoliated throughout the year by its ravages. Only in one park was it found, and here only in one clump of shrubbery, thus indicating that it has just been introduced there. I have been unable to find any record of the life history or food habits of this species. The eggs are deposited along the edge of the leaf within the tissue, the insertion of the ovipositor being made at the edge of the leaf between the tissues. The larvæ like other closely related species are voracious feeders. The adult larvæ make their cocoons in the soil just beneath the surface.

The second brood of the white-marked tussock-moth (*Hemerocampa leucostigma* S. & A.) was nearly as destructive as last year, when large numbers of trees in the parks and boulevards of Chicago were defoliated. The tussock-moth is by far the most common and destructive leaf-eating insect in Illinois.

The zebra-caterpillar (*Mamestra picta* Harr.) was found defoliating the cut-leaf elders in one park. It also damaged Tamarix and Hydrangea.

In the parks, and especially along the boulevards, the large webs of the fall web-worm (*Hyphantria cunea* Dru.) were found. They were not abundant enough to be noticeably injurious, but the webs gave the trees a most unsightly appearance.

I have never found the spring canker-worm (*Palcacrita vernata* Peck) common in Chicago, but in the vicinity of Big Rock, fifty miles

[1] Determined by C. A. Hart.

west, they have been very abundant for the past three years. Many fine old elms have already succumbed to its attacks.

Apatela populi Riley was unusually abundant in all parts of the city, in some cases poplars being defoliated by them.

The red spider (*Tetranychus bimaculatus* Harv.) was not so abundant as last year, but nevertheless it was present in destructive numbers, especially on elm. Not only do the infested leaves become yellow and sickly looking, but they also fall prematurely.

The wooly aphis of the hawthorne (*Schizoneura crataegi* Oestl.) was present, as usual, in very destructive numbers. It is found almost wholly on *Crataegus crus-galli,* and is abundant in all the parks.

The scale insects are of much importance in Chicago, the two most prolific and destructive being the scurfy (*Chionaspis americana* John.) and the oyster-shell (*Lepidosaphes ulmi* L.). Although the San José scale is present in Chicago, it multiplies very slowly, and does not readily spread to nearby trees and shrubs. Inasmuch as the scale is prolific and destructive twenty miles outside of the city, it appears probable that the reasons for its slow growth and spread within the city may be due to one or all of the following: Few birds are to be found in the city, and this lessens its chances of dispersal. The soot and smoke, which is ever present, in combination with moisture, forms acids, and this doubtless kills many individuals or weakens them so that they are unable to survive the winter or it may retard their growth. Further, the shrubs and trees in the city are poorly nourished, and it is known that scale insects are less prolific on such plants.

MR. SURFACE: The English sparrow is the chief transgressor in carrying the San José scale in our state, and if it was abundant in Chicago, I would suggest that it might be the chief cause of the trouble.

MR. BRAUCHER: I am inclined to believe that the slow spread of the scale insects in Chicago is partly due to climatic conditions and to the effect of the lake. In making observations on the time of hatching of the eggs of scale insects including the oyster-shell scale, I found there was several days' difference in the time of hatching of the eggs of the same species whether they were on trees close to the lake shore or whether fifty to one hundred yards back in the park. Where there is such a difference in so short a distance the lake must have a marked effect in checking reproduction and development and consequently the spread of the insect.

MR. DAVIS: The San José scale is a very injurious pest near

Chicago, and causes damage in close proximity to the lake, but seldom within the city, so I do not think the climate has much to do with it.

MR. SURFACE: I would like to have one more word as regards the spread of the San José scale. It moves with the wind, and in the orchards the wind should carry it more rapidly. That would be the reason for its spreading more rapidly in orchards and less rapidly in cities; although in the latter it is also disseminated by the English sparrow.

The following papers, owing to the absence of the authors, were read by title:

THE SEASON'S WORK ON ARSENICAL POISONING OF FRUIT TREES

By E. D. BALL, E. G. TITUS and J. E. GREAVES, *Utah Experiment Station, Logan*

As was suggested in a former paper[1] by the senior author, the determination of the effect of arsenical spraying on the life of our fruit trees is a problem of immense importance to the fruit interests of the country. The immediate solution of the problem is, however, of most vital importance to the western fruit growing sections as it is in these sections that the greatest amount of planting is now being done, a planting that would not be justified if the profits of orcharding are likely to be curtailed as has been recently suggested.[2]

It has, therefore, seemed advisable to present at this time a brief, preliminary report of the results of the investigations carried on by the Utah Experiment Station during the season of 1909.

Work of the Season

The season's work consisted of a study of the orchard and soil conditions in all of the principal apple producing sections west of the Rocky Mountains, together with various field and laboratory experiments to determine the effect of different strengths of arsenical compounds and different methods of application on plant growth. The study of western fruit conditions was mainly preliminary in nature and was undertaken with a view of determining the actual extent of the injury and to discover, if possible, the most favorable locations for the inauguration of detailed experiments. The experiments undertaken were also largely preliminary in nature and for the purpose

[1] Ball, Jl. Ec. Ento., 2, p. 143, 1909.
[2] Headden, Jl. Ec. Ento., 2, p. 245, 1909.

of mapping out the problem and determining methods of approach.

No single line of investigation was carried on long enough or thoroughly enough to warrant definite conclusions from this line of evidence alone. The results of the different lines undertaken, however, were in such close agreement with reference to the general principles involved, that taken together the results were very significant and seemed to warrant this preliminary publication.

It might be well to note in this connection that on account of the serious and lasting nature of the pear blight injury to the larger portion of the pear orchards of the inter-mountain region, and the impossibility of separating this injury from that of other causes, that the investigation was confined to the problem as presented in the apple orchards.

A Study of Western Orchard Regions

In the investigation of orchard regions a study was made of the more typical orchard soils especially with reference to their alkali content and general seepage conditions. Two or more of the oldest and longest sprayed of the commercial orchards located in each of the typical orchard regions were usually chosen and thoroughly investigated. On these orchards soil borings were made to ascertain depth of soil and distance to ground water and for chemical analysis. Samples of surface soil were collected to study the deposition of arsenic and samples of the trees taken to study its accumulation in the trees. In each of the orchards, the number of sprayings applied and the amount and kind of poison used were ascertained where possible. These orchards were taken as representatives of the better orchard conditions. In each valley at the same time, an attempt was made to ascertain the places where the greatest losses of trees were taking place and the conditions under which they occurred were investigated. Owing to sickness, the chemical investigations of this part of the work have not been completed and it is impossible at this time to give the detailed statement of the chemical findings.

It is hardly necessary to call attention to the fact that even under the most favorable environment there is an occasional loss of a tree through accident or individual weakness, and that even more frequently trees are permanently injured, especially in the region of the crown, through the ordinary processes of orchard cultivation.

The Pajaro Valley in California is the principal apple shipping section of that state. The soils are deep and range from loamy to heavy adobe. No irrigation water is used and no indication of alkali or of seepage conditions could be found in the principal orchard dis-

trict. The orchard of Mr. C. H. Rogers of Watsonville was chosen for investigation as being the oldest and longest sprayed of the commercial orchards. Spraying has been carried on in this valley for seven years and the average number of sprayings applied has been about four. Nowhere in the valley was evidence seen of injury to the trees of any kind other than accidental.

The **Rogue River Valley** of southern Oregon has a similar soil and uses very little irrigation water. No traces of alkali were seen except for a very slight spot in the lowest portion of the valley and the scarcity of water prevents the possibility of seepage conditions. The Burrell and Bear Creek orchards are two of the oldest in the Medford district and have been sprayed for a number of years, ever since spraying was undertaken in the valley. No injury could be found on any of the trees in these orchards or in any others examined except for the small alkali spot before mentioned, in which a few young Newtons that had never been sprayed, were dying.

In the **Hood River Valley** the soil is much lighter, consisting of volcanic ash, and little water is used, the orchardists depending very largely upon the excellence of their soil mulch, as they are compelled to do in the Rogue River Valley. No traces of alkali were seen in this valley and seepage is almost unknown, being confined to small and isolated spots in which the character of the injury is perfectly evident. No injury that could in any way be attributed to the effect of arsenic was found in this valley. Two of the oldest commercial orchards, those of Sears and Porter and of Chriss Dethman, were examined carefully. One had been sprayed for twelve years and the other for considerably longer, both of them heavily, as is the usual manner in Hood River, but without any apparent injury to the trees.

The **Wenatchee Valley** in Washington is one of the younger orchard valleys, but is already experiencing some trouble. In a number of places trees were seen dying of apparently typical cases of collar rot and often the last tree in the row, where the water had been allowed to stand was found to be dying or dead. They suffered somewhat from sunscald one season several years ago and the injury is still noticeable on many of the older trees, but wherever the trees were found to be dead or dying without showing the sunken area at the base, the evidence of excess of water, together with traces of alkali along the edges of the furrows where the water had stood, was always in evidence and where the collar rot condition was the most prevalent, brownish or whitish margins were present along the irrigation furrows and these areas were quite damp and sticky at the time the writer visited this section. Mr. Z. A. Lanhan's orchard and that of Mr. P.

P. Holcomb are among the oldest of the typical commercial orchards and have been sprayed rather heavily until recently. They do not, however, show as much indication of the trouble as many of the orchards which have been sprayed less and are located under less favorable soil conditions.

The Yakima Valley is located on the Snake River some distance below Wenatchee and like its sister valley has a variety of soils and a considerable amount of hardpan and seepage lands. Mr. William Richards has sprayed his orchard eleven years, six or seven times per year. Gibson Brothers, on similar soil, have been spraying for the same length of time. These orchards are both of them above the danger of seepage and very slight traces of alkali were visible and as far as they were observed, the orchards have not suffered in any way from their spraying. Mr. W. I. Huxtable's orchard which is on the higher lands of Knob Hill, was investigated and a white, impenetrable hardpan was encountered at about four feet, which seemed to be characteristic of the soils of this region. The trees in this section showed no apparent injury but on some of the older orchards the leaves were slightly yellow and the fruit small, indicating a lack of soil fertility. That it could not be due to any effect of the arsenic applied was evident from the fact that the same condition was observed on both apple and peach orchards. At a little lower level than this a large number of young trees just coming into bearing were observed to be dead or dying. Most of the trees affected were Spitzenbergs, and many of them had never been sprayed. In every case, however, the dead trees were found on the lower sides of the orchards where the irrigation water had been allowed to bank up against the roadway or ditch bank. In many of these places the ground showed unmistakable traces of alkali and the condition was apparently growing worse as the newer orchards showed only slight traces of it. It seemed probable that unless more care was used in handling the irrigation water in the future, considerable areas would be injured in this way.

A Ben Davis orchard was seen in this section that had been irrigated very late in the fall and as a result, almost every tree had been winter killed on the southwest side, the injury extending in some cases even to the upper sides of the limbs extending toward the northeast. This was the most severe case of scalding that has been observed and was considered to be caused by arsenical spraying until attention was called to the fact that every single tree was injured on the southwest side.

The Payette-Boise Valleys in Idaho are the largest apple producers and like other Snake River valleys, have considerable amounts

of hardpan at varying depths. These valleys are older than those in the lower Snake River district and the seepage conditions have grown worse from year to year until now large parts of a number of orchards on the lower levels, have been killed by alkaline ground water. On the higher levels the soil shows traces of alkali, but where the drainage is good no injury as yet has appeared on the trees. The orchards of Capt. J. H. Shawhan and of Bower and Hunter near Payette, of Hon. Edgar Wilson at Meridian, and Judge Fremont Woods near Boisé, were studied as typical of the better class of orchard soils in these valleys. These orchards have all been heavily sprayed for a number of years, representing the oldest of the commercial orchards in their districts and those that have received the greatest amount of spraying and yet they showed no sign of any injury attributable to that cause. These orchards all show distinct traces of alkali and it would seem to be a favorable condition for arsenic injury, if such occurs.

In **Utah** a number of new orchards have been examined in which Ben Davis and Gano trees are dying of collar rot, the greater number of them, however, being cases occurring in family orchards and on town lots where no spraying has ever been done. In Mr. Lars Nording's orchard at Hyrum, five Black Ben Davis trees, planted five years ago, began to die this season. This was the first season that they had borne and only one of them was sprayed, and even at the time that the spray was applied, the characteristic darkened area with oozing sap was seen at the base of the trees.

In **the Grande Valley** in Colorado a number of orchards pointed out as being typical cases of arsenical poisoning were examined, and in every case except one, unmistakable seep conditions were encountered within five to seven feet of the surface and in some cases even closer. Mr. F. T. Smith's orchard was typical of this class of orchards and in this case a considerable area showed a decided burning of the leaves in the early part of the summer. Mr. Smith reported that upon examination, at that time, he found the soil to be very dry and free from seepage conditions to a depth of six feet. When bored with a nine-foot augur later in the summer, the first six feet were found to be as dry as before but before reaching the seventh foot, the augur sank of its own weight into a soft, sticky ooze that extended as far as the augur would reach. In another place in which a strip had died near one end of an orchard, a soil boring made at the same time, only proceeded a little over two feet before the augur could be pushed clear down to the handle in a material similar to that found before. Mr. M. P. Hickman's orchard which was upon one of the higher mesas

and is claimed by other investigators to be free from alkali troubles, was the only exception to the finding of definite seep conditions and even in this orchard the second and third foot were found to be sandy and very wet and at the eighth foot another layer of wet sand was encountered. Along the edges of this orchard the alkali showing was quite marked and in an oblique strip running through the orchard in which most of the trees had died, some of them with rather typical collar rot conditions, the sides of the irrigation furrows showed unmistakable traces of alkali. It was also noticed that a crop of weeds had sprung up in the area where the trees were affected while the remaining portions of the orchard were quite bare, the cultivation having been the same throughout, indicating that the rising ground water had been sufficient to germinate seeds in the affected areas.

The orchard formerly owned by Dr. F. R. Smith is one of the oldest orchards in this valley and is located on top of one of the fruit ridges. This orchard is twenty-three years old and has received one hundred and eight heavy sprayings, perhaps the greatest amount of arsenic that has been applied to any orchard in this western country. As Doctor Smith relates, he sprayed until the water ran down the trees and saturated the bands, soaking the ground. For five years he used the Kedzie formula double strength and sprayed seven times a season. The orchard shows no indication of having been injured in any way by this excessive amount of spraying. This amount of poison is far more than would be necessary to protect a tree for its entire life under present methods of application. There is no sign of alkali in any part of this orchard, lying as it does on the crest of a narrow ridge, and in this orchard there seems to be the ideal condition for testing the possible effect of arsenic when free from the contaminating influence of alkaline waters, and as yet there is no evidence of injury. In fact, the orchard is in a remarkably healthy condition with the exception of one tree which is subject to overflow from a nearby ditch.

In the Delta-Montrose District a number of orchards which were pointed out as being affected by arsenical poisoning, were studied. Nearly all of the orchards of this section are located upon high mesa lands. The soils on the surface are usually fertile but vary considerably in depth. On boring, the soil augur usually encounters a calcareous hardpan, or "marl" layer, as it is called, at from eighteen inches to three or more feet from the surface. This layer is from one to two feet in thickness and is often penetrated by the roots of the trees. Throughout this entire district the Jonathan apples are more or less affected and in some orchards a considerable number have

died. Mr. L. W. Sweitzer's orchard, near Delta, presents a typical case of this kind. The Jonathans are becoming affected in small groups, while the blocks of Winesap, Gano and Black Twig are apparently uninjured. Upon examining the soil in the places where the Jonathans were dying, it was found that in every case the marl was near the surface in these areas, so near that oftentimes it would be pulled up with the roots of the trees. As has been noted by previous writers[3] when large limbs are sawed off from affected trees, they continue to bleed and deposit large masses of calcareous material. It is possible that the excess of this material in the sap is the cause of the trouble, but whatever it is, the Jonathan seems to be practically the only tree that is affected in this region, the Ganos in this same orchard being very healthy. Located as these orchards are on rather high and well drained mesa land, there is little trouble from alkali or seepage. The Ashenfelter orchard near Montrose is located upon a mesa in which this marly layer is particularly close to the surface and here the condition of the trees suggests a lack of fertility in the soil. This condition was apparent in this particular orchard before it came into bearing, and, therefore, before sprays were applied. This condition has been referred to as systemic arsenical poisoning.

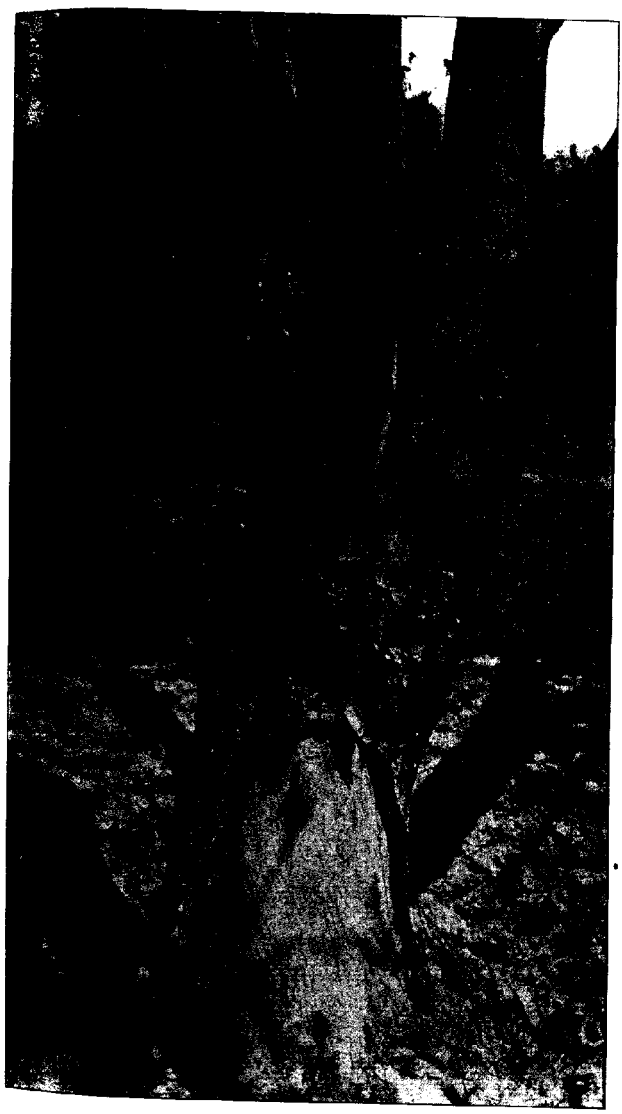
Summary of Orchard Investigations: It will be seen from the above descriptions that in the regions like the Pajaro Valley, the Rogue River and Hood River Valleys, where little or no irrigation water is used, and where if anything the orchards suffer from lack of water, and the soils are comparatively free from alkali, the troubles under consideration are entirely unknown.

That in every district in which the alkali is present in sufficient amounts to appear on the surface and where water is sufficiently abundant to cause seepage in the lower districts, that more or less of these root rot or collar rot conditions occur. In bad cases of seepage whole orchards are stricken within a year or two, oftentimes after they have borne a number of heavy crops. This may be due to a gradual rise of the ground water, or to the gradual extension downward of the roots of the trees. In milder cases, only here and there a tree is affected and these often linger along for a number of years, sometimes in a dry year, partially recovering, only to be stricken again in a wet one. If there is any perceptible slope to the ground the trouble will usually be more marked on the lower end of the irrigation furrows. Where alkali is evidently the cause of the death of the trees, no variety seems to be exempt, all being equally affected.

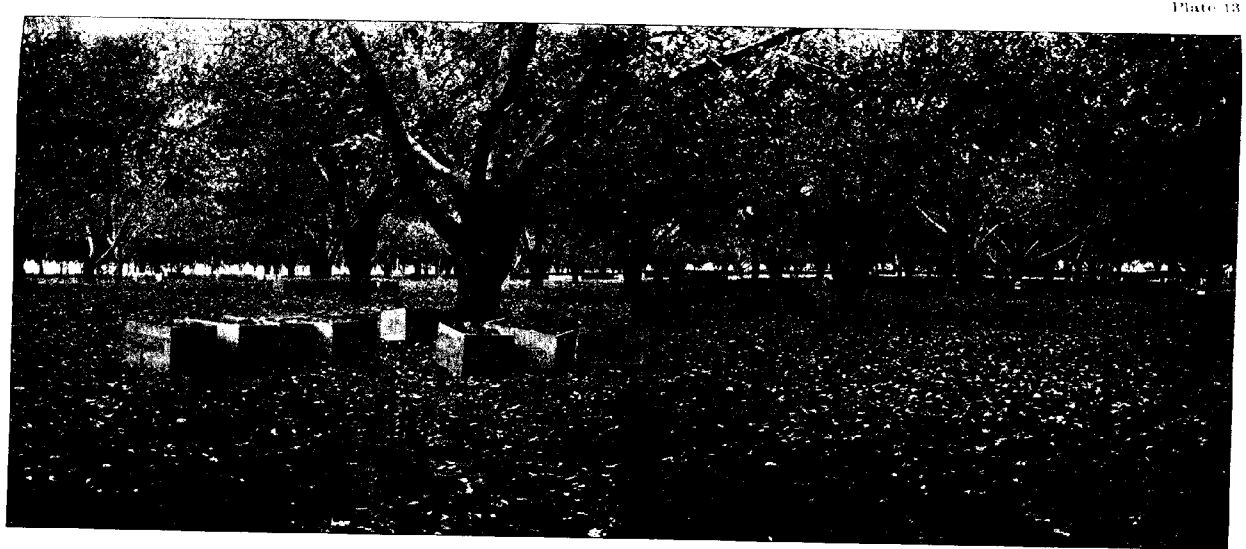
[3] Headden, Col. Exp. Sta. Bull. 131, p. 25, '08.

In a number of the higher valleys of Utah in which there is very little trace of alkali but where oftentimes the ground water is close to the surface, the apple trees of the Ben Davis and Gano varieties suffer from a condition which is commonly known as "collar rot." These trees often linger along for many years, new areas at the crown dying and then gradually healing over as the tree recovers, only to die in a new or larger area at a later date. This trouble seems to be almost exclusively confined to the Ben Davis-Gano type of tree and is occasionally met with throughout most of the apple growing regions. The real cause of this condition is still in doubt. It is usually first noticed just above the surface of the ground as a darkened area of bark which often exudes a few drops of a dark-colored, gummy liquid which later dries, and as the tree grows, this spot becomes a sunken area from which the bark gradually rots away.

The Grande Valley offers by far the worst case of seepage injury to be found in the western country. As the water has been taken out onto the upper lands, the lower ones have gradually been destroyed by the rising water. Hundreds of acres of orchard have already died and been removed and hundreds more are now more or less affected. Here, as everywhere else, the alkali condition is no respecter of variety or age. Every kind of a tree that occurs in the path of the seepage areas is killed and many young orchards of only one or two years' growth are dying. In fact, during the past season more trees under the bearing age were killed than were those above that age. It has been claimed that the higher regions, especially the mesas, were above the possibility of seepage, but this season has abundantly demonstrated that even these regions are not entirely exempt, as yearling trees on soil which has never grown apples before were killed in considerable numbers by white alkali within a few rods of the top of one of the best fruit ridges, as is shown in an accompanying photograph. With this picture in mind it is easy to see how it would be possible for trees to be killed by seepage on any of the adjoining mesas of similar elevation. There may be, and probably is, a small amount of the collar rot condition as found in Utah, present on some of these higher lands since the Ben Davis and Gano in certain sections seem to suffer more than other varieties. But it seems a rather peculiar logic to reason that these varieties are dying from arsenical poisoning in a valley where Jonathans are scarcely affected, and in the case of the very next valley to account for the death of a large number of Jonathans by arsenical poisoning where Ben Davis and Gano are not affected.

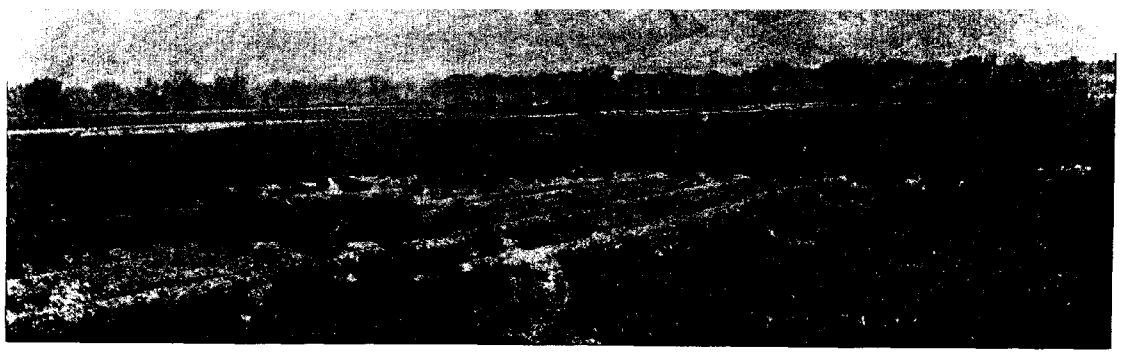


A bad "collar rot" case showing a partial recovery and growing over on one side. Notice the dead bark above and on the left side

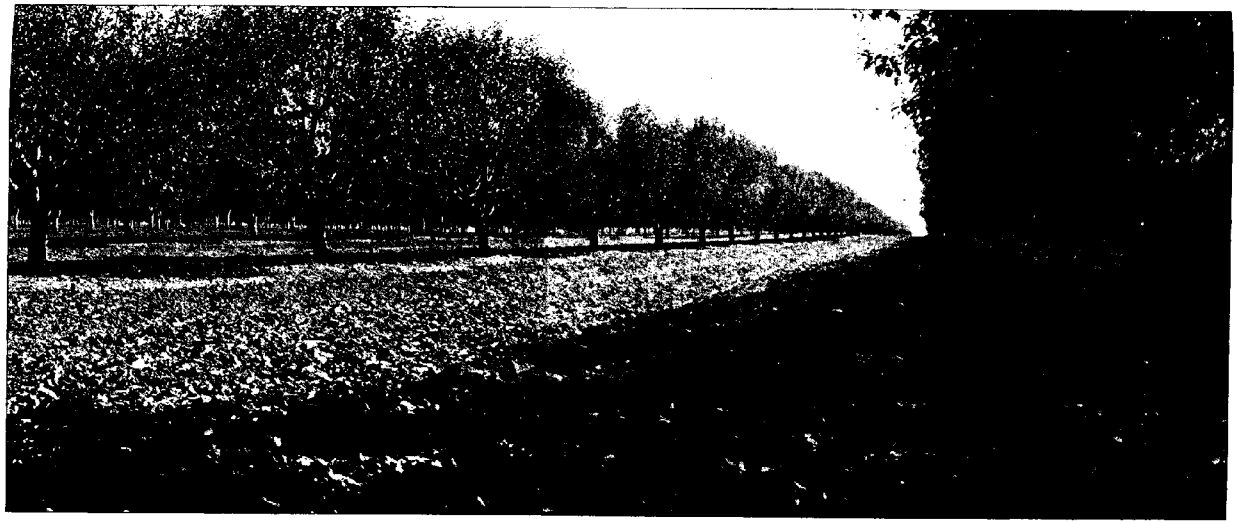


A view in Doctor Smith's orchard. This is one of the oldest in the Grand Valley and has probably received more spray than any other orchard in the west

Alkali killing young trees within a few rods of the top of a fruit ridge. Doctor Smith's orchard in the background



Alkali spots in alfalfa showing the spotted character of the Grand Valley soil



Doctor Miller's orchard at Austin above Delta, a typical mesa orchard and one of the most uniform seen in both stand and growth of trees

Experimental Results

It has been claimed that the greatest injury to the trees from the application of arsenicals was through their corrosive action in destroying the bark at the base of the trees. In order to test this experimentally as well as the possibility of the tree absorbing sufficient free arsenic through its roots to cause systemic poisoning, varying strengths of spraying compounds were applied to different Ben Davis trees. One set of trees received as much lead arsenate as would be required to protect them for ten years; another set for twenty years, and still another set with the amount required to protect trees for forty years. This would be approximately the amount applied to a tree during its entire life, as there are several years in which no sprays are applied at the beginning, and an occasional year in which there is no fruit and therefore no application of spraying material. All of the trees matured their fruit in perfect shape and even in the case of the heaviest application, the leaves were not seriously burned. The material was applied in the form of a spray with sufficient water so that it ran down the limbs and trunk in streams and dripped off from every part of the tree on to the ground to such an extent that, while the tree was whitened, and remained so all summer, the ground under the entire head of the tree was so saturated with the arsenic as to appear mouldy white to a depth of three or four inches. All of this poison was applied at the regular spraying time in the spring and the trees were irrigated in the normal manner during the season. An examination made in the fall disclosed no apparent injury to the bark of the trees at the crown and the roots near the surface had a normal healthy appearance. Part of these applications were made where there were weeds, alfalfa, and strawberries beneath the trees, and even with the heaviest applications no injury was observed upon the vegetation.

It will be necessary, of course, to continue this experiment for a number of years before any definite conclusions can be drawn, but it would seem that if the arsenic in the soil is freed in sufficient quantities from a few years' spraying to seriously injure or kill a tree, that enough arsenic would be freed in one year under like conditions from the excessive amount applied in this case to show some injury.

In order to further test the corrosive action of the arsenical compounds, the various spraying mixtures were applied directly to the bark of medium sized limbs of bearing trees, and maintained in contact with these limbs for a period of forty-five days during the latter part of the growing season. These experiments will be repeated on a much larger scale the coming season and it will, of course, be neces-

sary to study the effect for several years before it will be possible to give positive results.

Each spraying solution was applied in three strengths, double the normal, ten times and twenty times the normal strength. The double strength arsenate of lead produced no effect on the limb. The limbs upon which the two higher strengths of this solution were applied, showed a very slight burning on a few of the leaves soon afterwards, but the injury did not increase through the season.

The Kedzie arsenate showed no injury in any of the three strengths used.

Paris green in double strength showed no injury at all. The ten and twenty times normal strength caused a slight burning along the edges of the leaves.

A soluble arsenate (sodium arsenate) was also applied in three strengths, one-twentieth, the same amount, and twice as much as there would be of insoluble arsenic applied in the form of lead arsenate in a year of normal spraying. The two weaker strengths showed no injury at all. The double strength produced a browning of a few leaves early in the experiment but this did not increase and never became at all serious.

The above summary of the first year's work is, of course, in no sense conclusive but it would seem to indicate that the bark of an apple tree is not seriously affected by the normal spraying solutions even where they remain in contact with it for considerable times. The fact that the weaker strengths of the soluble arsenate produced no apparent injury is also quite suggestive because if the spraying solutions should fall into an alkaline soil at the base of the tree it is not likely that there would be more arsenic set free in a single season than was applied directly to the tree in this case, and therefore, if injury should be produced under the latter condition, some other factor would be necessary to account for the condition, other than the arsenic alone. And as alkali has killed thousands of trees where no arsenical sprays have ever been applied, it would seem natural to infer that the death of the trees, even where both substances were present, might be due, in a large measure at least, to the alkaline factor.

A number of other experiments have been carried on, such as growing various crops in soil taken from around the base of trees said to have died from arsenical poisoning; growing crops in soils in which large amounts of the different spraying solutions have been mixed, etc. Up to the present time, all of the results tend to confirm the conclusions drawn in the cases cited above.

The chemical examination of the orchard soils and of the trees for alkali and arsenic have not been completed, but the results so far are almost uniform in showing very small amounts of arsenic in the trees, from soils that are low in alkali, while all examinations so far in which a comparatively large amount of arsenic was found in the trees, have been from localities in which the alkali was so abundant in the soil as to be in itself a menace to orcharding.

Conclusion

While no definite conclusions can be drawn from these preliminary investigations as has already been suggested, it would appear that the injury to the apple trees in the western country may have a number of different causes. The evidence that alkaline seepage alone is sufficient to cause the death of fruit trees seems to be conclusive. The fact that the only places in which Jonathan trees are found to be dying in any numbers, where other trees similarly situated are not, are on areas underlaid with marl, suggests very strongly that there is some relation between that condition and the death of this variety of trees. The loss of a number of trees that have not been sprayed, in different sections where the alkali is apparently not present in sufficient quantities to be the killing agent, and the further fact that only the Ben Davis-Gano type are killed under such circumstances, indicates that we have a further factor to be considered, which we are at present calling "collar rot." That free arsenic if present in sufficient quantity will kill fruit trees has never been questioned, but the fact that all over the country the orchards which are located on suitable soils free from the other conditions mentioned, are showing no injury even where heavily sprayed for long periods of time, would seem to warrant the conclusion that has been previously stated by the senior author, that arsenical poisoning cannot be the primary cause of the death of the greater portions of our fruit trees. That where alkali is present in any quantity it is probable that the arsenic of the spraying solutions will be set free and will assist in the injury to the trees, but the question whether the alkali would be strong enough in this case to destroy the orchard within a few years without the other factor, is a problem yet to be solved.

NOTES ON "CIGARETTE BEETLE"

By P. H. Hertzog. *Lewisburg, Pa.*

Perhaps the name cigarette beetle carries a wrong meaning to the average tobacco dealer and layman, as the name may suggest that the insect is associated only with cigarettes. Hence some tobacco dealers pay very little attention to it, inasmuch as they have no cigarettes. But since leaf tobacco suffers the greatest loss, it would be more appropriate to call it "tobacco beetle."

Although the insect has been found feeding in various drugs and food, the fact remains that in this country, it is most conspicuous on account of the great injury and destruction to all forms of cured tobacco, such as leaf tobacco as well as manufactured tobacco in the shape of plug, snuff, cigarettes and cigars.

The beetle is less than one tenth of an inch long. Its color is brown and on that account it is not readily seen while on tobacco. The injury is mostly done by the larvæ which are worm-like grubs. But also adult beetles harm tobacco by eating their way out, thus leaving a hole about the size of a pin head. In case of cigars the eggs are usually wrapped in along with the tobacco while the cigars are being made. The egg then hatches in about ten days. Then the young larvæ eat through the tobacco including the wrapper. They often follow the veins of the leaf. One grub may thus make a number of perforations in its meandering course.

Several packers have declared to the writer that the insects can tell the difference between a good and an inferior quality of tobacco, and that they invariably choose to work in a good quality, such as expensive wrappers. Of course, this must be considered as a matter of chance and then, too, their work is sooner discovered in such tobacco.

The tobacco dealer has to consider it as a serious pest, however. Its presence in his establishment may mean thousands of dollars' loss and in addition may injure his trade, which is, perhaps, even a greater loss. Therefore, it is to his interest as well as to the tobacco industry that his place and other houses nearby should be as free from the pest as possible. It must be remembered that the beetle is a most rapid breeder under favorable circumstances, and that it is found in all states in the Union, wherever tobacco is handled or stored. During the past summer it was unusually abundant. The Bureau of Entomology of Washington, D. C., has received more inquiries this season from various sections than it has for some time. The above bureau

has taken steps to gather more definite statistics as to the extent of damage and distribution. In buildings heated during the winter, and in warm climates, it may breed the entire year. In a cold building they are inactive. In the latitude of Pennsylvania there are two broods running into each other, but the adult beetles are most abundant during the middle of June and again the middle of September.

The real proposition and question is how to get rid of it. A small quantity of tobacco may be readily and satisfactorily fumigated. But a large warehouse full is a different proposition. Especially so when the house is not of a very tight nature or when the cases are stored four or five rows deep and three or four layers on top of each other. Under such conditions it is impossible to fumigate successfully, since the gas could not readily reach the interior and lowermost cases. A packer will ask, will not the gas deteriorate the tobacco by bleaching it or imparting an odor? Will fumigation really kill the insects? During my summer's work, it was necessary in each instance to try a few cases in a sample room to show the merits of the work. In each instance the owners were pleased. As to the success of fumigation with hydrocyanic acid gas for the cigarette beetle, entomologists are somewhat divided, yet most see in it the most practicable remedy. This paper is based on the result of its use. It must be remembered that tobacco is one of the most difficult products to fumigate because the leaves pressed tightly against each other and the whole mass packed and pressed into the case forms an almost impenetrable mass. Fortunately most of the insects are on the outer portions of the case and especially at the butt end of the tied hands or bundles. It is there that they can gain the best entrance both into the case and into the tobacco. Most of the injury is done from the butt end in for about ten inches. The interior of the case, where the leaves are the most valuable, is usually free from insects. They eat inwards along and even through the ribs, piercing the leafy part at random. The gas may follow them in their channels. However, in order to do so a large amount of gas is necessary and a long time is required for it to penetrate.

Hydrocyanic acid gas gave most excellent results this summer. Yet it was by no means perfect. The ordinary directions and precautions for fumigating were followed. The formula per 1,000 cu. ft. of room space was 12 ounces of potassium cyanide, 20 ounces of sulphuric acid (liquid measure) and 40 ounces of water. The building is in very good condition, being as nearly gas tight as is to be expected. The gas was allowed to act over twenty-four hours. There was a two-foot aisle between the cases, but they were three cases high. The

lower row rested on scantling. Each case was opened by loosening the middle board at each end, that is, along the aisles, which end, fortunately, was the butt end. We think that such an arrangement and the opening of cases is very important for successful fumigation.

The first fumigation took place on July 10th. The bulk of the first brood had matured by this date. The beetles were numerous and active, flying about the room, collecting at the windows, crawling over the cases and laying eggs on the tobacco. A great many had died a natural death before, since many dead ones were found on the window sills and floor. No doubt many of these had previously laid their eggs. Probably the building should have been fumigated two weeks before so as to prevent egg laying. The gas killed practically all adults, pupæ, and larvæ. Although a few in each stage were found alive in protected places in the interior of cases, but only a few. A few adults were found at the windows immediately after ventilating the rooms. These no doubt were stragglers who had left the building and returned again or they may have come from some other house. The windows from now on were kept closed to keep outside beetles out. Fly paper was used liberally on the window sills and window sashes to catch stray beetles, who were usually attracted to the light. This proved to be useful. The most important floor was fumigated four weeks after the first fumigation. The entire building was fumigated to catch the second brood during the second week in September. After this last fumigation there was relief from the pest. Workmen say they have not seen any adults since. However, at this writing (December), a few larvæ have been found after careful searching.

Let us now see the fate of another house which was not fumigated. During the middle of September the second brood was at its height. Beetles were evident by great numbers crawling over cases of tobacco, in tobacco, at the windows and flying about wholesale. They were most active about dusk. Although this house was not fumigated they fought the insects with great vigor, using some novel methods, which helped much to keep the pest down. As has been mentioned before, the beetles are most active during the evening and since they are attracted by light, advantage was taken of these factors. A number of frames were arranged and lined with fly paper, placing a light in the middle, for the night, to attract the beetles. This was kept up during the bad season. Fly paper was tacked against cases and freely suspended from beams. The papers were changed as soon as they were covered with insects.

Another method that deserves attention is that of a suction arrangement. An electric motor was fastened to a force suction

machine. A large funnel from two to six feet in diameter was attached to the suction machine by means of a hose. The machine contained a fan or bellows which was run by the motor. Lights were fastened to the rim of the funnel. When the current was started, the fan caused a strong suction, drawing in dust and insects from the funnel'end, while the insects were blown out at the other end into a screen cage, which was attached to the receiving end. The size of the funnel depends on the power of the motor. The funnel may be shifted to cover more space. The entire apparatus may be mounted on a truck and moved by one man while another man shifts the funnel while the apparatus is moved along a row of cases. A funnel six feet in diameter, with sufficient power, will draw insects into it over an area of twelve to fifteen feet. By this method two persons have gathered over a pint of beetles in a single night. The method no doubt is a great help in keeping the numbers down, but it does not get at the root. It gives many beetles a chance to mate and lay eggs before they are captured. It is not thorough enough and only a part can be partly treated at a time. It may also be added that it is rather an expensive process, especially when electric lights are used. The method was used because the proprietors feared that fumigation would deteriorate the quality of tobacco. Comparing the above and fumigation, we must say that the results are decidedly conspicuous and in favor of fumigation. Although the latter costs more, it is very much more satisfactory. In the fumigated house practically no beetles were evident after the middle of September, while the other house was full of beetles until cold weather set in. The tobacco was also full of worms or larvæ.

One packer had intended to keep his tobacco at a low temperature of about 40°F. Since the larvæ are dormant in cold weather, it was thought that they could be starved. In order to do this it would have been necessary to equip the building with ammonia pipes. But when a contractor stated it would cost about $15,000 to $20,000 to simply install the plant, not counting running expenses, the plan was abandoned, especially so because the plan would have only been an experiment.

Steaming tobacco in the sweat room is sufficient to kill the pest in all stages. It ought to be kept in the room for two or three weeks at a temperature of about 120° to 140°F. Tobacco thus treated is free from the pest until reinfested. If the egg is not killed outright, its hatching is hastened and the young larva is then readily killed. Eggs normally hatch in about ten days. Unfortunately if tobacco is thus treated it may become reinfested during summer, the eggs

being laid by stray beetles, if the tobacco is exposed during the manufacture of cigars. In order to guard against this, cigars before leaving the factory should be fumigated thoroughly in a small room with H C N, then aired and packed. This would not cost much but it would practically insure the manufacturer's business.

The writer knows several parties, who turn out cigars that are free from the pest, although the tobacco was formerly infested. But by steaming the tobacco the pest was killed and then the tobacco is manufactured in a different town where there are no insects to reinfest.

If a single beneficial suggestion has been given or if the paper will induce some one to rid their house of the cigarette beetle by means of H C N, or otherwise, the writer feels that the paper has not been in vain.

For a fuller account of the cigarette beetle the reader is advised to consult Farmers' Bulletin No. 120 of the U. S. Department of Agriculture.

STUDIES OF THE DEVELOPMENT OF EUPELMUS ALLYNII FRENCH AND STICTONOTUS ISOSOMATUS RILEY

By E. O. G. Kelly, *Bureau of Entomology*

These two valuable parasites have been known to science and entomologists for about twenty-eight years. In 1881 and 1882, Prof. G. H. French reared adults of what is known as *Eupelmus allynii* from wheat straw and described the insect as *Isosoma allynii*. Professor French and Dr. C. V. Riley discovered that the insect was parasitic on *Isosoma grande* and that it did not belong to the genus *Isosoma*. Doctor Riley decided that the species belonged to the genus *Eupelmus* and it still remains *Eupelmus allynii*.

During this same winter of 1882, Doctor Riley reared and described adults of *Stictonotus isosomatis* parasitic on *Isosoma grande*.

Doctor Riley, Doctor Forbes, Professor French, Professor Webster and many other students of insects affecting cereal and forage crops have reared these parasites from the straw; and considerable has been written regarding their economic importance, but the larval habits have not heretofore been described.

The females of these two species have rather long pointed ovipositors with which they readily pierce the hard straw containing *Isosoma* sp., and puparium of the Hessian fly. The females put their

eggs into the cells of *Isosoma* larvæ, but not always on the larva itself; and inside the puparium of the Hessian fly, but, again, not into the larva.

Life History. During the early fall the egg hatches in three to six days, after deposition the tiny larva attaches itself to the host larva and sucks its life blood; they do not consume the skin of the host. The larvæ reach maturity in six to fifteen days and pupate in the *Isosoma* cell within the straw, and within the puparium of the Hessian fly. The pupæ are naked in both species. The pupal period ranges from seven to twelve days.

Eupelmus allynii hibernates in both the larval and pupal stages. *Stictonotus isosomatus* hibernates as pupa. Both species are found in cells of *Isosoma* sp. and in puparia of Hessian fly at this date (November 26, 1909). There were two distinct broods this year—one in early summer, the other in fall.

Descriptions. The eggs of the two species are quite different; that of *Eupelmus* is whitish in color and pedicellate. The bulb is elliptical in form, about .25 mm. in length and .12 mm. in width; the pedicel is slender, of uniform diameter and nearly as long as the bulb. The egg of *Stictonotus* is whitish in color, elliptical in form and about .3 mm. long and .12 mm. in width.

The larvæ of the two species, though quite similar when viewed without the aid of a magnifier, magnified they present some striking differences. *Eupelmus* larvæ have four distinct rows of bristles on the body, each segment having two dorsal and two ventral; the head bears two tiny brown mandibles; they vary in size from 2 to 4 mm. in length. *Stictonotus* larvæ are more cylindrical, have no bristles and no mandibles; they are 2 to 4 mm. in length. Both species are yellowish white in color.

The pupæ are quite different, *Eupelmus* being black with light rings on the abdomen, while *Stictonotus* has a dark thorax and yellowish abdomen.

A very interesting feature of parasitism presented itself while these studies were in progress. *Eupelmus allynii* larvæ were found attached to pupæ of *Stictonotus isosomatis* and reared to adult; and *Stictonotus isosomatis* larvæ WERE FOUND ATTACHED to pupæ of *Eupelmus allynii* and reared to adult. Parasitic larvæ were found attached to parasitic larvæ whose identity could not be determined because of mutilation or because of the desire of the writer to rear the secondary parasite. However, both species were reared from these larvæ, the host not being determined. In several instances tertiary parasites were found but failed to mature.

Some undetermined secondary parasites were reared from the larvæ of both *Eupelmus and Stictonotus.*

The writer is indebted to Mr. T. H. Parks, agent and expert in the Bureau of Entomology, for his kind assistance in collecting and rearing these parasites.

COLLEMBOLA AS INJURIOUS INSECTS

By WALTER E. COLLINGE, M. Sc., F. L. S., F. E. S., *Berkhamsted, England*

In a communication read at the Oxford Meeting of the Association of Economic Biologists[1] I drew attention to the part that various species of Collembola play as injurious insects and instanced many cases reported by Carpenter,[2] Curtis,[3] Ormerod,[4] Murray,[5] Guthrie,[6] myself,[7] and others, where they were the direct cause of damage to roots and seeds of healthy plants, and I incidentally pointed out, in referring to the nature of the injury, that they also play an important part in exposing different plants to the attacks of fungi by the injury they cause in wounding their surfaces.

Since then two facts have come to light which have an important bearing upon the subject.

The experiment I made I described as follows:

"During the past twelve months very careful observations have been made upon a series of common species which have fully established the fact that to orchards, numerous bulbs, beans and peas, the Collembola are distinctly injurious.

"The method adopted has been as follows:

"Shallow boxes, containing about four inches of moist soil, have been used, and into these perfectly healthy bulbs and beans have been placed. Into each box examples of different species of Collembola have been placed. The tops of the boxes in some cases were covered with a sheet of glass, and in others with a piece of wood.

"After the experiments were completed the soil and diseased bulbs were carefully examined, and apart from fungi no other pests were

[1] Journ. Economic Biol., 1909, Vol. IV, p. 83-86.
[2] Proc. Assoc. Econ. Biol., 1905, Vol. I, p. 14.
[3] Farm Insects, p. 432.
[4] Rpt. Obs. Inj. Insects for 1904, p. 110.
[5] Economic Entomology, Aptera, p. 404.
[6] The Collembola of Minnesota, 1903, p. 4.
[7] Rpt. on Inj. Insects for 1905, p. 10.

found, but in all cases the Collembola had increased largely in numbers."

At the time it did not occur to me to inquire "where did the fungi come from?" But since then this same soil has in part been used to pot bulbs in and the remainder was thrown onto the garden. In the pots and in the garden where this soil was placed there is now arising an abundant crop of different fungi.

As none of the fungi have previously been noticed in the garden and do not now occur, excepting in this restricted patch and in the pots, I think I am justified in concluding that the spores were originally introduced by the Collembola.

Doctor Buller[8] in his recent work states: "The gills of expanded fruit bodies are frequently visited, not only by Fungus Gnats, but also by Springtails (Collembola) . . . Some fruit bodies of *Polyporus squamosus*, which were growing on a log and had not yet become fully expanded, were infested with small black Collembola. There were as many as fifty to the square inch, and each one occupied a hymenial tube which was just wide enough to hold it. The Springtails (genus *Achorutes*), infesting *Stropharia semiglobata*, and some other species of Agaricineæ, were found to contain spores in the midgut," and it is well known to students of this interesting order that large numbers are found in such habitats. Hence these minute insects, quite apart from their own depredations, may prove a source by which various plant diseases may be introduced by spores which they carry upon their bodies. This I have proved to be actually so by washing various species in water and then examining the liquid, after the removal of the insects, in such case spores of fungi were particularly numerous.

SOME NOTES UPON THE LIFE HISTORY AND HABITS OF THE SORGHUM MIDGE

(*Contarinia* [*Diplosis*] *sorghicola* Coq.)

By W. Harper Dean, *Agent and Expert, Cereal and Forage Insect Investigations, U. S. Bureau Entomology*

Contarinia sorghicola Coq. occurs practically throughout the sorghum producing sections of the United States east of the 100th meridian. West of this line it is not known to occur at this writing. This species infests the seed of the many varieties of Sweet Sorghum,

[8] Researches on Fungi, London, 1909, p. 20.

Kaffir Corn, Broom Corn, Milo Maize and Johnson Grass (*Sorghum halapense*).

In one instance the writer induced this midge to oviposit within the seed of the common Fox tail grass (*Setaria glauca*), although the latter had not been listed among the hosts of *C. sorghicola* Coq.

The females oviposit within the seed glumes, placing the eggs close to the ovary. The newly hatched larvæ absorb the plant juices from the ovary and remain close against the latter until they have completed their growth and transformed into pupæ. The pupæ work their way upwards from the ovary until the apex of the seed is reached. There they remain until the adult is ready to emerge. At that time the pupæ work their way still farther up until about two-thirds of their length projects from the apex of the seed. In this position the adult liberates itself, leaving the cast pupal skin attached to the spikelet.

The larvæ are not cannabalistic; often as many as six in different stages of growth are found within a single seed while the writer has frequently removed eggs, larvæ and pupæ from one seed.

The Sorghum Midge is most thorough in its destruction of a crop of seed. In Midge infested sections rarely less than 90% of the growing seed are infested during the height of the season. The first and last heads are the ones least infested.

Copulation takes place immediately after emergence of the adult, the males hovering about the sorghum heads and seizing the females as fast as the latter leave the pupal skin — often before their wings have dried sufficiently for flight.

Immediately after copulation and when the wings are sufficiently dry for flight the females begin ovipositing. This is continued energetically until the quota of eggs has been deposited.

The time required for development from egg to imago varies considerably and is largely controlled by prevailing temperature and humidity. In the low country of southern Louisiana the time was much longer than in south central Texas where the heat is extreme and humidity very low.

The parasite, *Aprostocetus diplosidis* Crawford, is the predominant Midge parasite in Louisiana. During the summer of 1908 this parasite was successfully introduced into the fields around San Antonio, Texas, by Prof. F. M. Webster through the coöperation of Prof. Wilmon Newell of the Louisiana Crop Pest Commission.

Tetrastichus sp. Craw. has been bred from Midge infested sorghum seed by the writer along with the parasite *Aprostocetus diplosidis* Craw.

The Argentine Ant (*Iridomyrmex humilis* Mayr) ranks first among the Louisiana predaceous enemies of the Midge. This ant has not been found by the writer in Texas. The Argentine Ant in Louisiana attacks the Midge when the latter is in the pupa projecting from the apex of the seed just prior to the emergence of the adult. In this position it falls a ready prey to this enemy which seizes the pupa between its mandibles and draws it from the seed.

In Louisiana and also in Texas the writer has observed the fly, *Psilopodinus flaviceps* Aldrich, capture the adult midge when the latter is crawling over a seed head preparatory to ovipositing.

Several species of *Odonata* have been observed by the writer evidently capturing adults of the midge as the latter swarm about the seed heads although actual dissection of the stomachs of these flies has not been made in order to settle this point definitely.

SOME INSECTICIDE TESTS FOR THE DESTRUCTION OF APHIDIDAE AND THEIR EGGS

By C. P. GILLETTE, *Ft. Collins, Col.*

For some years past I have been making comparative tests of different insecticides for the destruction of plant lice (*Aphididæ*) and their eggs. The object of this paper is to announce a summary of the more important results only. I shall not even take time or space to refer to the work that others have done along the same lines.

The more important substances used have been emulsions, soaps, lime-sulfur preparations, and tobacco extracts in which nicotine is supposed to be the only active agent.

For the Destruction of Eggs

Kerosene emulsion was used in 35 different tests. In 8 of these no eggs were found hatched. Of the 27 applications which did not fully prevent hatching, 19 were above 16% oil, 8 were above 33% oil, and 2 were 50% oil. With less than 25% oil in the emulsion the eggs seemed to hatch as well as those untreated. Eggs of 4 species, *Aphis pomi, A. viburnicola, Chaitophorus negundinis* and *Melanoxanthoerium smithiæ*, were used.

Scalecide was used in proportions varying between 5 per cent and 25 per cent. Eggs hatched from 20 out of 22 treatments and from all strengths.

Thompson's Soluble Oil was used in 14 tests and in strengths

varying between 5 per cent and 20 per cent. Some of the eggs hatched from all strengths used.

The conclusion reached was that none of these oils can be depended upon to kill eggs of plant lice, though the lice that hatch upon twigs treated with the higher strengths very largely die from contact with the oily surfaces after hatching.

With these miscible oils, eggs of the same species were employed as in the kerosene emulsion experiments.

Soaps—Bowker's Tree Soap and Good's Whale-Oil Soap were used for 77 different treatments in strengths varying from 2 pounds to 1 gallon of water down to 1 pound in 6 gallons. None of the eggs of *A. pomi, A. cornifoliæ, Ch. negundinis* or *Mel. smithiæ,* which were treated with 2 pounds to 1 gallon, hatched. Eggs of the same species, and also of *A. viburnicola* hatched poorly when treated with a preparation of 1 pound to 1 gallon. Weaker dilutions seemed entirely valueless.

Lime Sulfur Mixture made by the 15–15–45 formula was also used against eggs of all the lice above mentioned and also those of *Myzus elæagni.* In this strength the lime-sulfur was a marked deterrent to hatching but all species hatched to some extent and some rather freely. Weaker applications had little effect. Over 70 applications were made. Where strong lime-sulfur applications are made, many lice die from contact with the lime-sulfur while struggling to extricate themselves from the egg shell and others die after leaving the shell and before taking food.

I might add that eggs of *Bryobia pratensis* hatched freely after thorough treatment with the 15–15–45 strength of this mixture.

Rex Lime-sulfur was also used many times in one-fourth, one-sixth, one-ninth, and one-twelfth full strength and with no better results than were obtained with the home-made product just mentioned.

Tobacco Extracts

Black Leaf Extract was used twice in one-twentieth strength and no eggs hatched. It was used 8 times in one-thirtieth strength and no eggs hatched. Seven applications were made in one-fortieth strength and in 5 cases none hatched, but in the 2 others a very few hatched. Weaker dilutions did little good.

Nikoteen was used 23 times in strengths varying between 1 in 100 and 1 in 500 parts and in only 3 cases did any lice hatch and these were all *Myzus elæagni.* The eggs of this species were the most resistant of any used in the various tests.

Sulphate of Nicotine was used 54 times in strengths varying between 1 in 50 and 1 in 500 and in no instance did an egg hatch. The species used were *A. pomi, A. cornifoliæ, A. viburnicola, Ch. negundinis, Mel. smithiæ,* and *My. elæagni.* The last named species was not treated with dilutions below 1 to 150. Eight applications of 1 to 750 resulted in a few hatching in one instance only. In weaker dilutions the number hatching gradually increased.

Nico-Fume was used in 55 applications in which the dilutions varied between 1 in 50 and 1 in 1,000 and in no case did a single egg hatch. In 1 to 1,200 some hatched; in 1 to 1,500 more hatched, and in 1 to 1,800 still more.

I hardly dare give out these results with the tobacco preparations; they are too good. I shall not fully believe them myself until I have tested them out another year with similar results.

All the applications that I am reporting were made in an insectary and the eggs were treated by dipping the twigs bearing them 3 or 4 times in quick succession into the various insecticides and then setting the twigs in moist earth in the insectary to be under observation until the lice hatched or until all hope of hatching was past.

Results With the Lice

Time will not permit me to go into this part of the work except to state that, in a general way, the results with the nicotine preparations run parallel with those above given. Black Leaf killed most lice well, down to a 1 per cent dilution and Sulphate of Nicotine and Nico-Fume killed most lice, well down to 1 part in 1,000, Nico-Fume having somewhat the advantage over the Sulphate in results.

In closing I would like to call attention to the fact that there is a great difference in different species of the Aphididæ as to their power to resist the action of contact insecticides. The eggs of *Chaitophorus negundinis* were more easily killed than those of any other species that I have worked with while the eggs of *Myzus elæagni* were the most difficult to destroy. I have found a thorough application of either Sulphate of Nicotine or Nico-Fume in the proportion of 1–1,000 to either *Aphis pomi* or *Schizoneura lanigera* will kill 100 per cent of those actually treated, while a similar treatment of the black chrysanthemum louse, *Macrosiphum sanborni,* will not kill one. Even 1 part in 100 is hardly strong enough to kill the latter species well, and 1 part in 200 is very inefficient, if used in the usual manner.

I find, however, by adding a small amount of soap, 1 pound to 50 gallons, the efficiency of these tobacco extracts is greatly increased.

In case of *M. sanborni*, for example, I found the addition of soap enabled either Sulphate of Nicotine or Nico-Fume to kill well down to 1 part in 800 or even 1,000 of water. The action of the soap seems to be merely to cause the fluids to wet and spread out upon the surface of the bodies of the lice instead of accumulating in drops and running off.

INSECT NOTES FROM NEW HAMPSHIRE FOR 1909

By E. Dwight Sanderson, *Durham, N. H.*

Insect life was unusually abundant and injurious in New Hampshire in 1909.

Aphids were unusually common during the late spring and early summer. *Aphis pomi* did much more injury than usual, especially to young apple trees and there were numerous complaints of its work. *Aphis setariæ* was common on cherry and plum thruout the state, curling the foliage very badly.

The pear leaf blister mite (*Eriophyes pyri*) has been common on pear for many years but has never been reported as a pest of apple until the past season in which we have received several reports from different parts of the state. It is interesting that New York State seems to set the style in insect pests as well as in other matters and that the neighboring states soon have the same troubles. The only explanation of the appearance of this mite in its new rôle as an apple pest is that suggested by Professor Parrott to me which may be due to dry seasons, of which we have had three in New Hampshire.

The apple leaf hopper (*Empoasca mali* LeB.) has been remarkably abundant and has caused a speckling of the apple foliage by a seeming destruction of the chlorophyl sap. I have not been able to observe any particular injury to old trees altho the numbers of insects have caused our fruit growers some alarm.

The spittle insect on pine (*Aphrophora parallela*) was very abundant, as in 1908, but we have been unable to relate its work in any way to the so-called pine blight. Its work is of no economic significance so far as we have been able to observe. The Fall web-worm and other caterpillars affecting apples in late summer have continued to be abundant as during the last two seasons.

The antlered maple worm (*Heterocampa guttivitta*) devastated the same territory as in 1908 and its injury was fully as severe. We had hardly expected to see severe injury by it this year but in view of the repetition of the outbreak this year we can see no reason why it may not be expected to be destructive in 1910. The trees in the worst

infested area have now been stripped of their foliage two years. Last year most of them leaved out in the fall but this year I am informed that many of them have failed to leaf out again. Undoubtedly many have already been killed and should they be stripped again immense areas of hard wood will undoubtedly be killed. Should this occur it would be the most serious injury to forest trees by a leaf eating caterpillar of which we know in this country. So far no parasites have been observed which are doing very effective work against the pest but the ground beetles, particularly *Calosoma frigida*, were present in large numbers and undoubtedly did very effective work both as larvæ and adults. The striped maple worm (*Anisota rubicunda*) and the spiny oak caterpillar (*Anisota stigma*) were again abundant on maple and oak over the same territory affected by the antlered maple worm.

For the last two years the elm leaf beetle (*Galerucella luteola*) has been becoming more abundant in the cities in the southeastern part of the state. The present year many of the trees in Newmarket, Exeter, Dover, Manchester and Nashua were entirely stripped of their foliage where they had not been sprayed. Another season effective work will undoubtedly be done against the pest by spraying. The unusual prevalence of this insect so far north can only be accounted for by our exceptionally dry summers and the rather open winters of the last two years. It is beyond its northern range as previously known to us and we shall expect to see it disappear and only break out under similar climatic conditions in the future. It may be possible, however, as Dr. H. T. Fernald has suggested, that it, as well as some other insects, will adapt themselves to a more northern habitat.

The brown-tail moth (*Euproctis chrysorrhœa*) is increasingly abundant in the more recently infested territory but altho we have made no careful survey of its spread, it seems to be spreading but very slowly toward the Connecticut Valley and to have reached its northern limit as we have previously predicted. Practically no serious injury is done by the insect in most of the territory north of Lake Winnipesaukee. In the worst infested region, as for instance in Durham, over 95 per cent of the caterpillars were killed off by a fungous disease altho there was hardly a normal rainfall. With normal rainfall in the spring and late summer the pest will undoubtedly be greatly reduced in numbers in the future. Spraying with arsenate of lead to destroy the young caterpillars during the first two weeks in August has been found exceedingly effective and cheap for both apple and shade trees, both in our own work and in that of our fruit growers.

The gipsy moth (*Porthetria dispar*) continues to spread and we

regret to state that except for the work being done by the U. S. Department of Agriculture that practically nothing is being done for its control either by the enforcement of the law or by the education of the people. The outlook for any possible control of the gipsy moth in southern New Hampshire is exceedingly dark and we are inclined to the belief that the only result possible is a very general and widespread destruction of the timber in southern New Hampshire, particularly the white pine, upon seeing which the people will probably awake to the necessity of handling such problems in a thoro going and scientific manner. The boll weevil has been a great blessing to Texas. We have already seen a considerable benefit from the brown-tail moth in New Hampshire in compelling the care of neglected orchards and the destruction of scattering trees. It is quite probable that the gipsy moth may be the means of arousing an appreciation of the value of our timber and shade trees and the rational growth and care of farm woodlots.

INSECTS NOTABLY INJURIOUS IN LOUISIANA DURING 1908 AND 1909

By Arthur H. Rosenfeld, *Baton Rouge, La.*

This article is prepared as a sort of continuation of the article by Mr. Wilmon Newell and the author, published in Volume 1 of the Journal of Economic Entomology.[1] We realize that a paper of this nature is not of particular interest at a meeting of this kind, nor does it require a great amount of scientific acumen to prepare such an article; however, we think that the value of such papers for reference use justifies their presentation here.

Cotton Insects

Practically the entire cotton area of Louisana, embracing some 34,000 square miles, is now infested with the boll-weevil, *Anthonomus grandis* Boh. As a result, the cotton acreage of the state has been much reduced, and this season Louisiana has made the shortest crop in all of her history — about 273,000 bales, against 517,000 in 1908, 610,724 in 1907, and 769,222 in 1906.

The boll-worm, *Heliothis obsoleta* Fab., has been, as usual, present in all parts of the state, but has not been particularly severe during the past two years.

[1] "A Brief Summary of the More Important Injurious Insects of Louisiana." Jour. E. E., Vol. I, page 150.

Neither the cotton caterpillar, *Alabama argillacea* Hübn., nor the square-borer, *Uranotes melinus* Hübn., have made their presence particularly felt during the past two years, but the past spring the cotton aphis, *Aphis gossypii* Glov., was very abundant, and badly injured the stand of cotton in many cases. This was undoubtedly due to the cold April. The cotton aphis is always a serious pest in cold, wet springs.

The cowpea pod-weevil, *Chalcodermus æneus* Boh., seems to be decidedly on the increase, judging from the large number of reports and specimens we have received during the past two springs. Early in the season, while the pod-weevils are waiting for cowpeas, they heavily infest the cotton, and often materially injure the stands by puncturing the leaf and terminal stems of the plants.

The garden web-worm, *Loxostege similalis* Guen., the differential locust, *Melanoplus differentialis* Thos., and the leaf-footed plant bug, *Leptoglossus phyllopus* Linn., have caused little trouble.

Sugar Cane Insects

The two principal cane insects, the cane borer, *Diatræa saccharalis* Fab., and the "pou-à-poussiere," *Pseudococcus calceolariæ* Mask., have been about normally abundant, although we have found that the infested territory is larger than we knew of in 1907, in the case of both insects. The Bureau of Entomology has taken up a study of sugar cane and rice insects, in coöperation with the Louisiana State Crop Pest Commission, also a study of the Argentine ant, which is supposed to be the principal means of transportation of the "pou-à-poussiere."

Insects Injurious to Cereal and Forage Crops

None of our principal corn insects, the boll-worm, the cane borer, or the Southern corn root-worm, *Diabrotica duodecimpunctata* Oliv., have been more than usually abundant on corn.

The rice maggot, *Lissorhoptrus simplex*, Say, did a great deal of damage the past spring. Thousands of specimens were sent into the Commission, which had flown to lights.

The sugar-cane beetle, *Ligyrus rugiceps* Lec., was not reported as unduly numerous, but the author noticed vast numbers of them at Crowley, La., in the heart of the rice-belt, attracted to the lights of the city. Thousands of them were lying upon the walks under each electric light, and they were flying into houses and stores in great abundance.

The fall army worm, *Laphygma frugiperda* Sm. & Abb., was seriously abundant in some sections, particular injury being done to young rice. The author saw one 10-acre corn field near Hammond, La., made as bare in a few days as if there had been no crop on the land whatsoever.

The destructive pea aphis, *Nectarophora pisi* Kalt., and the onion thrips, *Thrips tabaci* Lind., did considerable damage in St. Bernard Parish, the extreme southeastern parish of the state, though the damage was not as serious by either species as in 1907.

Truck Crop Insects

A few specimens of the Colorado potato-beetle, *Leptinotarsa decemlineata* Say, have been received at the office of the Commission, but this insect is usually conspicuous by its absence.

The sweet potato borer, *Cylas formicarius* Fab., has been, as usual, quite common in South Louisiana, and the ever-present Harlequin cabbage-bug, *Murgantia histrionica* Hahn., has been heard from only occasionally.

The imported cabbage worm, *Pontia rapæ* Sch., has been more numerous the past fall than in many years. On account of decreased cotton acreage, considerable truck has been planted in some sections of Louisiana, and a large amount of fall cabbage was this year grown. Most of the cabbage growers are yet unfamiliar with the insects attacking this crop, and, as a result, the imported cabbage worm did an unusually large amount of damage.

The past fall, also, was notable for its tremendous number of bean leaf-beetle, *Ceratoma trifurcata* Forst. Cowpeas and all sorts of beans were badly riddled, and applications of arsenate of lead seemed to have little effect.

The striped cucumber beetle, *Diabrotica vittata* Fab., was another common insect which was unusually numerous the past season.

The squash lady beetle, *Epilachna borealis,* Fab., is always found in small numbers, scattered over the state.

Insects Injurious to Stored Products

The insects in stored food-stuffs, etc., in Louisiana, are legion. Among the commonest are the drug-store beetle, *Sitodrepa panicea* Linn., the saw-toothed grain-beetle, *Silvanus surinamensis* Linn., the rust-red flour beetle, *Tribolium ferrugineum* Fab., the cadelle, *Tenebrioides mauritanica* Linn., the cigarette beetle, *Lasioderma testaceum* Dufts, the rice weevil, *Calandra oryzæ* L., the granary weevil,

Calandra granaria Linn., *Alphitobius diaperinus* Panz., *Rhizopertha pusilla* Fab. and others.

Our three most common cockroaches are the American cockroach, *Periplaneta americana* Linn., a closely related species, *P. brunnea* Burm., and the cosmopolitan croton bug, *Blatella germanica* Linn.

Insects Affecting Deciduous Fruits

The same Coccids as were noted in the article by Newell and Rosenfeld, mentioned above, have been noticed during the past two years, and none have increased to an alarming extent. The San José scale, *Aspidiotus perniciosus* Comst., has been held well in check in the nurseries in which it occurs, and we have not been able to locate any newly infested districts for the West Indian peach scale, *Aulacaspis pentagona* Targ.

In September last, Mr. C. W. Flynn, while inspecting nurseries in New Orleans, sent in some Coccids on young fig trees from China, said by the nurseryman to have been brought to him by a sea-captain. Doctor Howard identified these scale insects as *Asterolecanium pustulans* Ckll. Mrs. Fernald, in her catalogue, gives as the habitat of this insect, Jamaica, Porto Rico, Antigua, Brazil, Br. Guiana, Grenada, Monserrat, Mexico and Florida. As this is a new insect to us in Louisiana, we had the nurseryman destroy the few fig trees infested.

The peach-borer, *Sanninoidea exitiosa* Say, and the plum-curculio, *Conotrachelus nenuphar* Herbst, have been about normally abundant, but the shot-hole borer, *Scolytus rugulosus* Ratz., has done more than its usual damage, especially to peach, this being doubtless due to the fact that a late freeze last spring materially weakened a number of peach trees which were pretty well advanced.

The woolly apple aphis, *Schizoneura lanigera* Hausm., and the apple-tree tent caterpillar, *Malacosoma americana* Fab., have been very little in evidence of late. This is also true of the American procris, *Harrisina americana* Guer.

An insect which we did not before know to occur in the state is the strawberry root louse, *Aphis forbesi* Weed. In April, 1908, a few specimens were sent in, and an investigation by the writer revealed the fact that it was very common all over Tangipahoa Parish, our principal strawberry section. During the past spring this insect was also found by the writer at Baton Rouge.

The destructive mealy-bug, *Pseudococcus citri*, Risso, is commonly abundant on figs, Japanese persimmons, and oranges.

Citrus Fruit Insects

On the orange insects there need be no especial comment except in the case of the white fly, *Aleyrodes citri* R. & H. This insect has again gained a foothold in Plaquemines Parish, the principal orange-growing section of the State, and this season has done considerable damage. Efforts are being made to hold this insect in check by means of the various fungus enemies which have given good results in Florida, and with fair results. The white fly was formerly very abundant in the orange groves of Plaquemines Parish, but was practically eradicated there by the destructive freeze of February, 1899, which killed most of the orange trees in Louisiana and Florida.

Insects Injurious to Pecans

The walnut caterpillar, *Datana integerrima* G. & R., has done considerable damage to pecan foliage, while the fall webworm, *Hyphantria cunea* Dru., and the hickory twig-girdler, *Oncideres cingulata* Say, have been about normally abundant. More than the usual number of complaints of attacks of the pecan huskworm, *Enarmonia prunivora* Fitch, have been received.

In December, 1908, Mr. T. C. Barber collected a number of newly budded pecan branches (ring budded) which showed indications of the attack of boring larvæ. On investigation a number of Sesiid larvæ were found, in one case thirty being dug from a single limb. They seemed to enter through the wound caused by the budding and to work upwards from the bud. This caused a large swelling at the point of injury, which was covered with the borings of the larvæ. Three infested limbs were placed in the insectary, and in March the adults began to emerge, something like fifty specimens emerging from these three small pieces of infested limbs between March 24 and April 28, 1909. Doctor Dyar kindly identified the moth as *Sesia corusca* Hy Edw.

The obscure scale, *Chrysomphalus obscurus* Comst., has been found abundant on pecan trees all over Louisiana. *Cecidomyia carya* O. S. is also abundant in all parts of the state, on wild pignut as well as on cultivated pecan.

We have on record one case of severe injury to a pecan tree at Morgan City, La., by an ambrosia beetle, identified by Prof. F. H. Chittenden, of the Bureau of Entomology, as *Platypus compositus* Say.

The two May beetles, *Lachnosterna prunina* Lec., and *L. fusca* Froh., which were very destructive locally in some sections in north-

west Louisiana in 1905, have not made their appearance in such destructive numbers since that time.

Insects Injurious to Shade and Ornamental Trees

In this class we have found nothing of especial importance, the pests mentioned in the above-mentioned article being present in about normal quantity. The Gulf Fritillary, *Dione vanillæ* Linn., is almost always found upon the passion-vine, *Passaflora incarnata*, with which a number of the galleries in various parts of South Louisiana are covered, and the dropping of the spiny red and black "worms" has "almost caused" untold cases of feminine hysterics!

The larvæ of *Homaledra sabalella* Cham., (kindly identified by Mr. Busck), have caused considerable injury to palms in Calcasieu Parish, in the southwestern part of the state, during the past summer. They fold the leaves and feed inside the inclosure thus made, skeletonizing the leaves.

Insects Attacking Men and Live Stock

Nothing of interest has transpired among these insects during the past two seasons. We have had no severe outbreaks of the buffalo gnat, *Simulium pecuarum* Riley, reported to us. This insect at times appears in destructive numbers, and the loss of a large amount of stock always results. The horn-fly, *Hæmatobia serrata* R.-D., has been very abundant in parts of the state, and has caused considerable annoyance to farmers in the infested districts. The various species of *Tabanus* and *Chrysops* have been noticed in about their usual numbers.

The chicken mite, *Dermanysus gallinæ* Redi, has been several times out into the office with complaints of injury and annoyance.

NOTES ON CALOSOMA FRIGIDUM KIRBY, A NATIVE BENEFICIAL INSECT[1]

By A. F. Burgess, *Melrose Highlands, Mass.*

During the past three seasons extensive investigations have been carried on at the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass., in order to secure more accurate knowledge of the biology of the European parasitic and predaceous insects that are being introduced for the purpose of securing the natural control of the Gypsy and Brown-Tail Moths. Considerable data has also been obtained concerning native species which destroy some of our common

[1] Occasional contributions from the Gypsy Moth Parasite Laboratory, III.

insect pests, an unusual opportunity was offered in 1909, on account of the extreme abundance of the Saddled Prominent (*Heterocampa guttivitta*) in Maine and New Hampshire.

For two years previously large areas of deciduous forests in these states had been defoliated by this insect, and its unusual abundance and the noticeable character of the injury caused led many landowners to fear that irreparable damage would result. During the summer of 1908 reports relative to this insect were issued by Miss Edith M. Patch,[2] Entomologist to the Maine Agricultural Experiment Station, Prof. E. F. Hitchings, State Entomologist of Maine, and C. F. Jackson[3], Assistant Entomologist, New Hampshire Agricultural Experiment Station, and last summer the outbreaks of the previous year were followed up by the above officials and their assistants.

In each of these reports mention was made of the fact that certain predaceous beetles, particularly *Calosoma frigidum,* were found in considerable numbers in the badly infested sections and as this genus of beneficial insects is receiving special study in connection with the Gypsy moth work, it seemed desirable to secure as much data as possible to determine whether the species was doing any considerable amount of good.

Accordingly an arrangement was made with Prof. E. D. Sanderson and on July 31 Mr. W. F. Fiske and the writer accompanied Professor Sanderson on a tour of a part of the infested district in New Hampshire. A visit was made to several badly infested localities in the town of Tamworth, in the foothills of the White Mountains and a colony of larvæ of the European beetle, *Calosoma sycophanta* was liberated. These insects had been reared at the Parasite Laboratory in Massachusetts and previous to this time over 6,000 had been liberated in Gypsy moth infested colonies in that state. The caterpillar stage of that insect having passed, it was thought desirable to liberate this colony in New Hampshire where the beetle larvæ could obtain sufficient food to attain full development. Adults of *Calosoma frigidum* were common in this locality, where they were observed climbing the trees and feeding freely on the *Heterocampa* larvæ. No beetle larvæ were observed at this place. Another badly infested area was visited in the same town. A large acreage on the hillsides had been completely defoliated and many *Heterocampa* larvæ were crawling about on the ground and the trunks of the trees in a vain search for food. This area had been defoliated the previous year. Many beetles were

[2] Bulletin No. 161, Maine Agricultural Experiment Station.

[3] 19th and 20th An. Repts. N. H. Agric. Expt. Sta., 1908, p. 514–531.

found and several larvæ were seen on the ground feeding on the caterpillars. A square yard of ground was carefully examined by Mr. Fiske and the writer, and 12 *frigidum* larvæ were found just beneath leaves and litter. They were busily engaged in feeding on the caterpillars that had crawled under the forest cover for the purpose of pupation.

On the following day a badly infested area was examined near White Horse Mountain, near North Conway, and although it was not possible, owing to lack of time, to make a thorough survey of the defoliated area, very little search was required to discover many of the beetles. This colony was located on the side of the mountain and the caterpillars were not as far advanced as those seen at Tamworth. At one place on the edge of the badly infested area upwards of 100 beetles were found busily engaged in climbing the trees and feeding on the caterpillars. Few *Heterocampa* larvæ were found under the leaves and no beetle larvæ were seen.

Mr. C. O. Bailey, Secretary to the Massachusetts State Forester, informed me that while driving at Effingham, New Hampshire, August 1, 1909, he observed large areas of woodland that had been stripped by *Heterocampa*. At one place the trees had been completely defoliated and countless numbers of the caterpillars were seen crawling across the road. They were being attacked by *Calosoma frigidum*, which species was present in large numbers.

As few parasitic insects were observed it was thought desirable to make another trip later in the season in order to check up the data secured, and accordingly on August 21 Mr. Fiske and Mr. Harry S. Smith went to North Conway for that purpose. After finishing the investigations made in the localities visited on the previous trip Mr. Fiske returned, and Mr. Smith spent several days examining other defoliated areas on Mount Kearsarge and in the surrounding territory.

A summary of the notes made by Mr. Smith, so far as they relate to *Calosoma frigidum*, has been very kindly placed at my disposal, while those bearing on certain parasitic forms will be used by him after more information has been secured next season.

At the time of this visit *Heterocampa* were nearly all in the pupal stage beneath the leaves and rubbish on the ground, and as *frigidum* larvæ were present in considerable quantities, and actively engaged in feeding on the pupæ counts were made to determine the relative percentage of pupæ destroyed. About a square yard of ground was examined in each locality, 29 sets of data being secured. In five of these no *frigidum* larvæ were found but the number of pupæ that

had been destroyed ranged from 60 to 100 per cent, the average being 78 per cent by the beetle larvæ and 4.5 per cent by all other enemies. In these areas the trees had been stripped early in the season and the beetle larvæ had become full grown and gone into the ground to pupate before the examination was made.

In the remaining 24 areas examined *frigidum* larvæ ranging from newly hatched to nearly full fed were found. In one case 21 larvæ were discovered feeding on pupæ. At this time the number of pupæ that had been killed by the larvæ of *frigidum* varied from 11.7 per cent to 80.2 per cent, the average being 54 per cent of the total number of pupæ. Where the lower percentages were found a considerable number of small *frigidum* larvæ were present. The following table has been compiled from the data secured:

TABLE SHOWING THE NUMBER OF *HETEROCAMPA* PUPÆ DESTROYED BY LARVÆ OF *CALOSOMA FRIGIDUM*

Stages of *C. frigidum* larvæ found				Pupæ of *Heterocampa*				
First	Second	Third	Adults	Healthy	Eaten	Parasitized	Diseased	% Destroyed
2	2	2	2	17[1]	4	.....	4	15.3
3	8	7	1	15	30	.....	1	62.5
.....	4	.....	.....	23	15	.....	.....	39.4
2	4	15	.....	8	37	.....	.....	80.2
1	2	.....	.....	50[2]	9	.....	2	14.7
1	1	3	1	6	8	.....	.....	57.1
.....	2	.....	1	14	2	.....	1	11.7
.....	.....	1	.....	3	4	.....	.....	57.1
.....	.....	1	.....	6	21	3 ?	.....	70.0
1	3	2	.....	19	16	.....	1 heat?	44.4
.....	2	3	.....	10	11	.....	2 "	47.8
1	1	3	.....	14	37	.....	.....	72.5
.....	1	2	.....	27	51	.....	.....	65.3
.....	4	3	.....	47	44	.....	.....	48.8
.....	1	.....	.....	18	10	.....	.....	43.5
2	3	6	.....	36	39	.....	.....	52.0
.....	1	1	.....	14	16	.....	.....	53.3
.....	1	1	.....	1	19	.....	.....	95.0
1	2	1	.....	6	10	.....	.....	62.2
1	.....	7	.....	34	38	.....	.....	52.5
.....	.....	1	.....	12	28	.....	.....	70.0
.....	2	1	.....	30	52	.....	.....	63.4
.....	.....	1	.....	23	15	.....	.....	39.5
.....	.....	1	.....	39	50	.....	.....	56.1
15	44	62	5	467	566	.....	.....	.....

[1] Also one larva of *Heterocampa*. [2] Also two larvæ of *Heterocampa*.

Several of the larvæ included under the column "Diseased" probably died from exposure to heat.

No later examination of this territory could be made so it is impossible to state from actual counts the percentage of pupæ that were destroyed before the beetle larvæ became full fed.

The data available showing the amount of food consumed by the larvæ of *frigidum* in its different stages is far from complete but from such feeding records as have been obtained at the Gypsy Moth Parasite Laboratory, together with those secured by the writer several years ago when the life history of this species was investigated,[1] it appears that the following amount of food for each stage is a very conservative estimate; first stage 2, second stage 5, and third stage 7 full grown gypsy moth larvæ.

If the beetle larvæ found continued to feed until full grown or until the food supply was exhausted, as would be the case in some of the areas examined, they would at the end of the season destroy, on the average for all the areas examined, 92 per cent of the pupæ present.

It is, of course, impossible to determine the number of *Heterocampa* larvæ that were destroyed by the beetles and their larvæ but from the above data it is easy to see that the increase of the species was greatly retarded during the past season, in the localities mentioned, by this beneficial insect.

Calosoma frigidum is found throughout New England and is often present in large numbers during outbreaks of caterpillars. There are specimens in the United States National Museum at Washington, D. C., which were taken in Illinois, Maryland and Michigan, which indicates that this insect has a wide range.

It is probable that the unusual increase of this species in the infested district in New Hampshire is due largely to the abundance of a satisfactory food supply. A study of the reproductive habits of a limited number of specimens, made by the writer in 1896, showed that 186 eggs were deposited, in one case, by a female fed in captivity, and observations which were continued the following year led to the discovery that eggs are laid by some females for two successive years. The habit of the *Heterocampa* larvæ of pupating on the ground beneath leaves and rubbish makes them particularly susceptible to the attack of the larvæ of this beetle, which naturally feed in such situations. The larvæ of *Calosoma sycophanta* have been found climbing trees, especially those that have rough bark, where they

[1] Notes on certain Coleoptera known to attack the gypsy moth, 44th Annual Report Mass. State Board of Agriculture, 1896, p. 412–426.

feed on caterpillars and pupæ of various insects. *Frigidum* larvæ were not observed on tree trunks in the areas examined in New Hampshire but it was not necessary for them to climb as plenty of food was available on the ground.

Miss Edith M. Patch has found these larvæ, as well as the beetles, feeding on *Heterocampa* caterpillars, on tree trunks, which shows that it is possible for the larvæ to climb to secure food in case it is necessary to do so.

The abundance of *Heterocampa* next summer in the sections examined will, of course, offer interesting data on the value of *Calosoma frigidum* in controlling this insect.

This concludes the Proceedings.

A. F. BURGESS, *Secretary.*

Panama Ticks.—We notice in Mr. Hooker's list of Dec., 1909, p. 415, of ticks from Panama no mention of two of our common species, *Amblyomma dissimile*, the common iguana tick of this region, and *Amblyomma varium*, taken from *Bufo marinus*, our common toad; determinations made by Banks and Hunter. This last tick has been of some interest to us for it is probably the intermediary host of *Filaria* sp., and also of a Hemogregarine. Sections of adult ticks showed undoubted development of filaria embryos. The blood of every one of eight specimens of this toad contained filaria embryos, and each one of the adults dissected had three or four adult filaria in the lymph sinuses. The blood of five of the toads contained the hemogragarine. All of the toads were infected by *Amblyomma varium*.

DR. SAMUEL T. DARLING,
Chief, Board of Health Laboratory, Ancon Hospital, Isthmus of Panama.

Proceedings of the Eighth Annual Meeting of Horticultural Inspectors[1]

(Continued from the February issue)

Evening Session, December 26, 1909, Continued.

President Washburn presiding.

The President presented Professor Surface, who read the following paper:

RESULTS OF VARIOUS REMEDIES FOR SAN JOSE SCALE, IN PENNSYLVANIA ORCHARDS, AS SEEN BY THE INSPECTORS IN THE ORCHARDS

By H. A. Surface, *Harrisburg, Pa.*

[Withdrawn for publication elsewhere]

WHAT SHOULD BE THE FORM OF OUR CERTIFICATES?

By Franklin Sherman, Jr., *Raleigh, N. C.*

For some years I have been considering whether we entomologists especially those of us in the eastern states) can devise some method of bringing our certificates of nursery inspection more nearly in line with the facts as they really exist. I violate no confidence in saying that the certificates as now issued in all of our eastern states are

[1] A Correction

It appears that Professor Headlee was incorrectly reported on pages 80-81 of our February issue. The following is therefore inserted at his request and gives the tenor of his remarks.—Ed.

The Farmer's Institute organization in Kansas has been able to engage a practical, up-to-date horticulturist. This man goes about the state conducting the fruit-production side of the regular institutes. He meets with fruit growers, finds out their problems, and gives them the benefit of his long and successful experience. On request he visits individual fruit plantations, looks carefully into local conditions, and suggests methods whereby the yield may be improved.

In general, our people do not know how to grow high grade fruit, although our regular fruit growers produce fruit that will compare very favorably with the best grown in the country. The Farmer's Institute organiza-

misleading to one not on the inside. We all know how binding are the conditions which have led us into this practice and I cannot say that I am yet quite ready to take a step which shall make North Carolina appear different from all her neighboring states, for such a step could, and probably would, be seized upon by some nurseries in other states and used to our disadvantage, when those very nurseries would likely be no better, and perhaps worse, than our own home nurseries.

Now the essential point of our present system which I object to is this:— We give certificates which are so worded as to plainly imply that the nurseries are "free, or apparently free," from the San José Scale, and we issue these certificates after scale *has* been found in the nursery, we issue them to nurseries where it has been found with more or less regularity for years past, where we know the scale is well established, and where we are reasonably sure that it will be found in the future. We fully recognize the fact, and freely admit it among ourselves, that it is not practicable, nor would it be just to bar a well-established nursery from trade, when it has won a large number of loyal customers many of whom would rather take the stock of that nursery even without certificate and taking the chance of scale, rather than to deal with someone else. Then again, there is the complication that much of the stock is really sold through agents or advance orders, long before the nursery is inspected.

But perhaps the most irritating fact of all is that if one of us, in the zeal of clearing his conscience and of trying to make the deal square with the word, were to actually knock out every nursery in his state which was found to have San José Scale,— that state might at once become a most profitable field for exploitation by nurseries in other states who were in the possession of certificates that they were "apparently free" and which as a matter of fact might be, and very likely would be, in worse condition than the nurseries that were put

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tion is trying, through education, to bring about the production of better fruit. At present the horticulturist does not have many requests for consultation, but the number is increasing and no doubt in a short time he will have far more than he can attend to.

Kansas is a large state and although the eastern and central portions will produce excellent fruit-bearing trees and shrubs, many parts of the west will grow orchards only under irrigation.

In Kansas the fruit institute movement has just made a beginning. The Farmer's Institute, of which the fruit institute is just one phase, is organized and looked after by a special agent known as the Superintendent of Farmer's Institutes. This official has his office at the agricultural college and his work has met with such keen appreciation that the last Legislature voted $50,000 to carry it forward.

out of business,—for the very entomologist who would be so strict and so conscientious as to take this step is the very one whose state nurseries would likely be in as good condition as any. Hence no one of us has felt that he could afford to take the step, and we have all preferred to compromise ourselves to this extent rather than expose our nurseries to unfair competition and to subject the fruit-growers and farmers of our states to exploitation in the way described.

It seems to me that we have now reached the point where a change should be adopted, or at least tried experimentally. The San José Scale is now so wide-spread through all the eastern states that it is idle to talk of keeping our fruit-growing sections clear of it,—it is already present in almost every locality where there are extensive orchards, and in many such localities it is to be found in practically every orchard. Also it is no longer a pest which must be fought by preventive measures chiefly, for the remedies are so well known that there is no excuse for trees being killed by it *after the owner once knows of its presence.*

Then again let us remember that under the head of "serious insects and diseases" which our certificates are intended to cover, are included such pests as woolly aphis, crown gall, oyster shell scale, brown-tail moth, etc. I cannot believe that all the nurseries which we certify can by any stretch of the imagination be considered as even "*apparently* free" of all these.

I have therefore prepared for the consideration of this meeting a proposed form of certificate which I should like to have discussed. Here it is:—

THIS IS TO CERTIFY:—

That a duly authorized and competent inspector has made inspection of the salable nursery stock of ———— at ———— N. C., to ascertain condition as to insect pests and plant diseases, and said nursery is licensed until the expiration of this certificate.

This certificate may be suspended or revoked for cause.

THIS CERTIFICATE EXPIRES SEPTEMBER 30, 1910.

Dated,—Raleigh, N. C., ———— 1910.

————,

Entomologist.

I do not see as such certificate would give an unscrupulous nurseryman any advantage which he does not already have, nor do I see that it would take from the entomologist any advantage that he now has. I do not believe that "the ultimate consumer" would care a snap about the changed wording just so his protection is not weakened. We could retain the same privilege which some of us now use, of

requiring other nurseries to get tags from us before shipping into our state,—we could still have the right to destroy infested shipments. Nor do I believe that it would be injurious to those nurseries which are really apparently free from San José Scale.

However, I do a little bit fear that if we were to make such a change in our certificate, there would be some very enterprising nurserymen from some of the states which *might not* adopt the change, who would flood the other states with agents who would tell the people that our state nurseries were admittedly unsafe to buy stock from and then in support would show that we did not give a statement of freedom from scale, while their state did!

Altogether, I must confess that I am not immovably set in my conviction that this scheme would work entirely well, but I would be willing to go home, broach it to the nurserymen and fruit-growers of my state and adopt it for the coming year, if enough others would join with me to give it a really full and fair trial.

Tuesday Evening, December 28, 1909

Discussion in regard to certificates, as proposed by Sherman:

MR. PHILLIPS: In all cases the stock should be examined, and it should be understood that no certificate should go on any stock carrying the San José scale.

My inspectors are instructed not to pass trees that are infested with San José scale. All plants so marked are condemned and destroyed.

PRESIDENT WASHBURN: This is really very interesting. We would like to hear from other members.

MR. PHILLIPS: We have discussed this matter year after year: in fact, we had an important meeting in Washington a few years ago, and discussed about the same idea, although we did not present it in the form of a certificate.

At that time it was decided that the time had not come for making a change. I think Mr. Sherman's ideas are very good, and touch a point on which I would like to get an expression from the Association.

There is always some nurseryman here and there who has lost a few dollars by not keeping his nursery stock clean, and has objections to raise to inspection, and in order to get an understanding as to how this Association feels in regard to this certificate, I would like to make a motion that if such a certificate as Professor Sherman indicates is issued, and has the endorsement of the Association, that it shall not

cover a single tree infested with San Jose Scale, any more than any certificate mentioned heretofore; in other words, that the certificate be understood not to cover a single tree infested with San José Scale. Of course, every one knows that you will find a tree now and then slightly affected. The idea I want to get at is that infested or affected trees should not be sent out from the nursery, and I make a motion to emphasize this point.

PRESIDENT WASHBURN: I think perhaps Mr. Phillips' motion is a little premature. We can use it later on.

MR. S. J. HUNTER: In Kansas when inspection is made and scale is found on a man's premises, regardless of whether it is in his nursery stock or in his orchard no certificate of inspection is issued. The nursery stock receives a tree to tree inspection and all stock destroyed within dangerous proximity of any stock found infested. The stock which is left is subjected to the standard fumigation process under the immediate direction of an inspector. Each consignment of this stock is accompanied by a special tag stating that such has been fumigated and giving the exact invoice of the consignment.

MR. BURGESS: Although I was not present when the paper was read, I would suggest that the certificates should show that the nursery had been examined and that the stock contained in each shipment was apparently free from injurious insects and plant diseases. I can see no deception in issuing such a certificate even if a slight infestation was found in the nursery at the time of inspection, provided the inspector has taken every precaution to free the premises from infestation and that he is satisfied that the stock shipped is free from pests as stated in his certificate. If the stock is fumigated before shipment I believe a certificate to that effect is an advantage.

PRESIDENT WASHBURN: I think the statement which Mr. Burgess just made is right to the point. I believe this is a matter which can safely be left to the good sense of the inspectors. Our common sense will tell us when a nurseryman has good stock, and if he is entitled to his certificate. I do not believe any of us would give a man a certificate if he did not deserve it.

SOME OBSCURE DISEASES OF PEACH

By J. B. S. Norton, *College Park, Md.*

Introduction

Perhaps most of our cultivated plants are troubled with many physiological diseases of more or less consequence, many of which, though they may cut off the crop seriously each year, do not receive notice, as their symptoms are not marked enough to attract attention as specific diseases; though some are well known because so serious that they could not escape notice by either cultivators or pathologists.

It is comparatively easy to work with a disease when the cause can be easily seen with the naked eye, as with most of our insect troubles. And if by careful microscopic work a pathogenic fungus or bacterium can be discovered, it is again a more or less simple matter. So much so, that practically all of our training has been along the line of insect and fungous parasites; a basis for pathological work which is not strictly logical, as these are only parts of the more fundamental science of pathology which deals with all abnormal variations in nutrition, respiration, stimulation, etc. But, we instinctively look for a parasite and are baffled when we come to a serious disease without any causative organ other than the diseased plant itself.

So far as I know the peach has more serious diseases, the cause of which has not been definitely determined, than any other crop we grow. It is only by extensive study of these under a great variety of conditions that we can obtain accurate information on such disturbances in plant health, and for that reason, I wish to here give a brief account of such as have come to my notice from personal experience and a recent examination of the available literature.

Not all the diseases, the causes of which are unknown may be non-parasitic; some may be caused by yet unknown bacteria, fungi, insects or other animal parasites, and in that case or even if due to a contagious ferment, as may be the case in the yellows, may come under the domain of the horticultural inspector.

Yellows

I shall mention first what has been determined about peach yellows (See Erwin Smith, also Clinton and other recent authors.) Briefly, this is a definite disease, characterized by premature ripening of the fruit, which is peculiarly red blotched, internally red streaked, and of poor quality, premature growth of leaf-buds, and even flower

buds, producing small, narrow and usually yellowish foliage, and later clusters of weak shoots, followed in three to six years by death. It was first known near Philadelphia over one hundred years ago and is now found from Canada south to central Delaware and Maryland, from thence extending southward east of the mountains to Georgia. Westward it is serious in Ohio, Michigan, etc., and occurs west of the Mississippi as far south as Arkansas. It has not spread southward very much in Maryland and Delaware, in twenty years. In the region where it is found, it is constantly present, but has had several much more serious outbreaks; sometimes destroying ninety per cent of the orchards in one year.

Yellows can be transmitted to a healthy tree by union with a living portion of a diseased tree, but in no other known manner, except to some extent by means of diseased pits, of which, however, only a small percentage usually germinate. (Warren [N. J. 1906] got twenty-seven per cent germination from 620 natural pits and only two per cent from 321 of four varieties of canning house pits; see also Phillips' work in Virginia.) It has been noticed that in orchards where diseased trees are kept cut out, fewer new cases appear, indicating some other kind of infection.

The disease is present in the tree some months before it is apparent and may show first only in a part of the tree. It cannot be cut out in such cases, and though diseased wood is lacking in lime and has an excess of potash, it cannot be corrected by fertilizers. It also attacks apricots, almonds and Japan plums and similar diseases occur in several herbaceous plants and some other trees. It is not due to root aphis, lack of iron, or any kind of impoverished soil; if anything, the trees making more vigorous growth being more subject to yellows. Overbearing, also, is against the disease rather than favoring it.

Many fungicides, including Bordeaux mixture sprayings and many secret remedies have been tested without success. No case of recovery is well authenticated. Many theories as to cause have been tested and inoculations with many fungi and bacteria have been tried without success.

The distribution indicates a relation to a certain climatic zone and many observations point to an increase of yellows after injurious weather conditions, such as drouth, following severe winter or late spring freezes. Individual trees show great resistance and some varieties seem more resistant in some cases than others. None are immune, not even naturals. Trees have lived in infected districts for fifteen to thirty years and then died of the disease. (Morse cites

the case of the White Magdalen variety that has grown 150 years in Massachusetts without contracting the disease.)

Since in our work we have to do more work with this disease than the others I shall mention, I shall take a little more time with it and mention some of the points which are in much need of further study, as apparently no extensive scientific work has been done on this important disease for nearly twenty years.

First. Can the disease be communicated by the pruning knife, contact, etc., or by sap or other non-living matter from diseased trees?

Second. Can the disease be produced in healthy trees far south of the yellows region by budding from diseased northern stock? Also would young diseased trees recover if transported to the south? Apparently any quantity of trees have been sent south from infected districts without spread of the disease, though healthy trees from the south have not shown immunity.

Third. The southern and western limit of the disease should be again accurately determined, and a careful survey of the infected region made to determine if there are within it isolated areas free from the disease. The border line should be completely explored for cases of recovery or recent extension of the disease limitation.

Fourth. What is the relative resistance of different varieties? Old trees standing for years after the surrounding ones have gone out with yellows should be propagated from to secure possible resistant stock.

Fifth. Tabulate from orchard inspection and weather records accurately kept for many years, the relation of warm, cold, wet and dry seasons and late spring frosts to increase or decrease of yellows in following years. Three or four seasons records in Maryland indicate that yellows outbreaks follow severe cold after buds open in spring. In this connection, the influence of different slopes or exposure and effect of late and early blooming might be considered.

Sixth. Careful examination of records should be made to certainly determine whether removal decreases infection or spread, bearing in mind the possibility that new cases may be due to climatic or soil conditions.

Seventh. We need a thorough chemical study of the relative amount of organic compounds associated with nutrition such as, starch, sugar, acid, tannin, proteid, enzymes, etc. There are several diseases of other plants closely resembling yellows, such as the Serah disease of sugar cane, dwarf mulberry disease, mosaic disease of tobacco, etc., in which the disturbance has been more definitely worked out, and while it is said that yellows is such an enzyme disease, no chemical study of it

has been published other than the fifteen to twenty years old ash analyses, though very complete analyses of healthy peach were published by the Bureau of chemistry in 1905.

Rosette

Another somewhat similar disease known as rosette, found first locally in Georgia some fifteen years ago, is distinguished by the absence of premature fruit (the fruit becoming gummy and falling before ripening), more tufted growth and death after a shorter time five months to two years). It has since been found in South Carolina, Alabama, Oklahoma, and in 1901 in Missouri. The past summer, I found that it had killed most of the peach orchards about Manhattan, Kansas, where, 15 years ago, it was confined to one or two orchards. I also found it along the Kansas valley as far east as Topeka and extending up the Blue river, possibly into Nebraska. I may say that some nurserymen are obtaining pits from this part of Kansas, in the belief that this is out of the limit of the infected district.

Little Peach

Little peach is in some ways a similar disease characterized by the fruit ripening late and very small, the foliage being small, yellowish or red and inclined to roll, the tree dying in two to three years. When the wiry shoots which are sometimes produced as in yellows are present and the fruit absent, it cannot be distinguished from the latter disease. It was first reported from Michigan in 1896 and has since been found in New York, New Jersey, Connecticut (?), Delaware and possibly Maryland. No cause has been discovered but it seems to be contagious.

The occurrence of this disease along the northern border of the yellows region and the rosette along the southern border would suggest that these three diseases which can with difficulty be distinguished at certain times, might be climatic forms of one disease, though one would hardly be rash enough to add such a theory to a question already overburdened with theory.

A suspected case of little peach reported from New York was found to be due to imperfect fertilization, the pit being small and without kernel.

Injuries by Low Temperature

A number of peculiar peach troubles are to be attributed to winter injury and perhaps low temperature is associated with more than

have been assigned to such a cause as the peach is especially sensitive to cold. In cases of collar-girdling, root-rot, stag-head, poor growth and yellow foliage, one should look for the darkened wood due to severe cold which may kill it up to the cambium without destroying the latter. A great deal of trouble of various character at the base of the tree may be due to cold. In a large number of cases, which I saw several years ago in Maryland and similar instances mentioned by Clinton in Connecticut, the root, or the bark at the base of the stem seems to be injured while the top is left in fairly healthful condition. Whether we are right in attributing this to winter injury I am not certain. In some low land near sea level, I had thought that salt water overflow might have been the cause, but the Delaware Experiment Station reports benefit from such a case (1895) rather than injury.

I have noticed in Maryland associated with these basal injuries, an abundant fungous growth resembling the *Cytospora* noted by Stewart as occurring with dead or dying peach in New York, and causing white flattened shot like bodies under pimples. Its parasitism has not been determined.

Frost-crack, body-blight or sunscald seems to be due mostly to extremes of temperature in late winter and spring. Trees making vigorous growth are said to be injured less than old or young trees, and freeze more easily than the middle aged.

Failure of Young Trees

Young trees when set often refuse to grow. Some of this may be due to methods of planting or soil conditions. But I attribute a great deal of it to drying or freezing of the root during the winter storage, in shipping or while planting. Warren has made some tests in New Jersey of the effect of exposure of different duration and found that roots exposed to evaporation for one hour were severely injured.

In speaking of storage troubles, I may mention the fatal fungous trouble (species not identified) found in New York in 1900 where sand was thrown over the stock in the cellar.

Dwarfing and poor growth or early failure may result from grafting upon plum or other stocks that are soon grown over by the more vigorous peach.

A yet unexplained condition found to be causing much loss in several Maryland orchards the past year, in which the base of the stem is swollen, soft and cracked and the main lateral roots are cut off by a regular abscission layer, may be due to partial drying out of the root.

Spray and Other Chemical Injuries

There are still some unsolved problems connected with injuries from copper, arsenic and other spray materials, the peach being especially sensitive to such, though much has been cleared up by Bain and others. Some peculiar physiological disturbances come from the use of oils, and much injury resulted especially in the old days of kerosene and crude petroleum spraying for scale. I do not know of any one having yet worked out the physiological effect of oil upon trees or upon fungi. Whether the peculiar rough bark often seen on peaches sprayed with oil is due to the latter or to recovery from scale I cannot say.

Some of our mysterious troubles may be due to dipping in oils or other materials. Close (Delaware) found severe injury to peach dipped in crude petroleum and more when dipped in kerosene. Symons (Maryland) found injury from oil dipping in some cases. He found more injury when roots were dipped.

Silver Leaf

A condition of peach foliage called silver leaf due to unknown causes has been known in England for years and is reported as serious and contagious. A silvery appearance is common on peach leaves in autumn in this country. I was told by Professor A. L. Quaintance in 1901 that this was due to the work of a mite, but I can find no publication on this trouble except the description of the silvering mite by Banks in 1905.

Split Pit

Split pit is a common and not definitely explained condition. In England it is attributed to excessive and unequal growth of inner and outer parts of the fruit due to rapid growth at fruiting time. Piper says that in the western United States twig borers are the cause of some of it. Another writer says these only enter the previously split pits. It was noted as serious in California in 1904.

I shall now mention some conditions due to various causes, which we may best group under their most noticeable symptoms.

Root Rot

Frequently trees blossom out then stop growing or make an unsatisfactory growth and then die. In such cases the root is often full of fungous mycelium. Several fungi (for example, *Clitocybe parasitica*), (Missouri and Oklahoma) and other Basidiomycetes

(California), *Rosellinia radiciperda* (New Zealand), Ozonium, etc., have been assigned as the cause. Some of the observed fungi undoubtedly follow previous injury by low temperature, wet soil, or other causes interfering with root respiration. Even the undoubted parasites may be assisted in their attack by such conditions. Selby found it more frequent on clay soil in Ohio. It is a common trouble in Oklahoma and Texas.

Gummosis

The ordinary cells of the peach are easily transformed into the gum commonly found about injured peach tissues. Gummosis usually begins in some wound where gum forming enzymes develop and may bring about extensive degeneration. Bacteria (see work in U. S. Dept. Agriculture and Brzezinski in Compt. Rend. 1902) as well as several fungi have been found associated with gummosis and in some cases definitely causing it. It is usually to be looked upon as the indication of some other trouble and may be associated with brown rot, borers, bark beetle, scale, excess of nitrogen, and especially frost, which often leaves patches of bark separated from the wood where the gummosis enzyme starts to work.

Cankers, Knots and Constrictions

Cankers may be formed by various peach fungi keeping open wounds which the tree is trying to heal. Constrictions indicated by the yellow, rolled foliage from uncut bud-wrappings, label wire, etc., are often seen. I have seen a few cases like the above where the constriction was due to the killing of the bark which was dried to the wood and covered with small pycnidia filled with Pestalozzia like spores. Other causes are: overgrowing the stock as when grafted on sand cherry and American plum, attacks of *Phoma persicæ*, other fungi, etc.

A knot of swelling of twigs is described by Selby in Ohio (1898), clubbed branches noted by Erwin Smith (1892), a tuberculosis attributed to a species of Clostridium occurs in Europe, MacOwen reports at the Cape of Good Hope (1899) knotlike growth followed by death of the twigs bearing them, and a case of swollen and blistered peach trees in England is reported in Gardeners Chronicle 1897.

Shot Hole and Leaf Spot

The cause of the Shot hole effect in leaves may be difficult to find as the affected portion is cut away by the peach itself. Spray injuries

and various fungi, such as *Cercospora circumcissa, C. persicæ, Phyllosticta persicæ* (in Maryland last summer), *Macrosporium commune* (Michigan), *Bacterium pruni*, etc., have been noted as causing these troubles.

Chlorosis

Aside from the yellowness of foliage mentioned already under yellows, etc., a yellow foliage condition is well known in Europe under the name of Chlorosis.

Powell (Delaware 1897) reports a case of yellowish willow-like shoots, from newly budded stock, identified by experts as yellows, but which disappeared as the trees grew older. He attributes it to influence of the bud and weather conditions causing late growth. These yellows-like shoots are often seen in nurseries and when older trees have been severely pruned, or when growth has been checked by grafting, bending, or constricting a branch.

Following the excessive wet spring of 1909 in Kansas, I noticed that the foliage at the ends of many peach branches as well as on other species was almost white. Selby attributes to wet soil, a variegated foliage with yellow along the veins, seen in Ohio; and Stewart and Blodgett report a condition with watery edge to the leaves, later becoming yellow and passing into tip burn; cause unknown.

Leaf Roll, Wilt, Leaf and Fruit Drop

These conditions may be due to various troubles, girdling by borers, wire, winter injury, dry or stony soil (see Johnson's frenching disease, Maryland 1896) or even to wet soil, in addition to such diseases as yellows and little peach. Wilting due to unknown causes has been mentioned by several writers.

A bud dropping disease (cause unknown) is reported from South Africa and similar troubles in English greenhouses are attributed to improper ventilation.

The June drop has been rather a mystery but probably is as Waugh says due to combined action of nonpollination, curculio and the struggle for existence.

Prematuring of Fruit

This may be caused by yellows (in which case it is distinguished by the peculiar red spots) by borers, or by girdling in other ways.

Twig Spot

The well known grayish, purple bordered twig-spots seem to be due to the fruit scab fungus. I found similar spores developing from them last spring (See Duggar, Fungous Diseases). Stone and Monahan mention a twig-spot due to a Monilia.

Twig Blight, Staghead or Dieback

The cause of death of branches is so varied as to be extremely confusing. I may mention among fungi: *Phoma persicæ, Sclerotinia fructigena, Valsa leucostoma, Coryneum beyerinkii, Nœmospora crocea* also old age, poor soil conditions, yellows, spraying mixtures, oils in particular and probably some lime sulfur, cold weather, etc.

Fungus and Insect Troubles

Many diseases due to vegetable parasites have been pretty well cleared up: such as crown gall, brown rot, leaf curl, bacterial leaf spot, fruit scab, frosty mildew, California blight, powdery mildew, rust, and fruit rot due to *Glœosporium lœticolor* and *Aspergillus glaucus*. But among these and others many points in nomenclature, pathology and treatment are yet unsettled.

It is hardly worth while to mention the large list of other fungi given by Saccardo as occurring on peach but not mentioned in recent pathological literature. But many of these occurring even on dead tissues only may be stages of active parasites which are yet to be worked out.

The many disturbances due to insects and other animals, I shall not mention, as they are out of my domain except to say that in addition to the simple injuries they cause, definite diseased conditions are due to nematodes, San José Scale, borers, curculio, root aphis, etc.

LOCAL INSPECTION, PUBLIC SPRAYERS AND THE OSAGE ORANGE HEDGE

By Thomas B. Symons, *College Park, Md.*

Mr. President and fellow members:

The title of these remarks would seem to indicate a rather elementary discussion to present to this Association, yet it seems to me that we should not lose sight of these practical problems with which each of us come in contact in the performance of our several duties. There

is no doubt that much practical information has accumulated as the result of comparatively recent investigations throughout the country, that has not as yet reached the men or farmers in whose interest the work was undertaken. I, therefore, consider the proper dissemination of facts already known to those who need the information as important a problem as the seeking of new facts looking towards the mitigation of many existing troubles. Moreover, as professional men, I consider that we should aim as far as possible to stimulate means whereby our theoretical instructions, so to speak, may be put into practice. The mere fact of advising a grower what he should do in order to relieve a certain condition or save a certain crop is not sufficient. It is somewhat similar to a doctor prescribing a medicine that cannot be procured at the drug store within a reasonable time or without a great expense.

The third subject of my title is one in which as inspectors, we should be especially interested and as men seeking to improve the economic status of our constituents, we should spend every effort in conducting an interstate campaign towards the elimination of this constant menace to our farmers and fruit growers.

With this introduction, I shall discuss briefly these three subjects, giving our experience in Maryland with the desire to stimulate further discussion by the Association.

Local Inspection

Upon the enactment of the Maryland Inspection law, the officers charged with its enforcement found difficulty in disseminating the desired information to the mass of growers as well as in getting amicable and practical compliance with the law by negligent orchardists.

It was apparent that the orchards of the state should be inspected both for the benefit of the growers as well as to do justice to the nurserymen. It was difficult, however, to devise means for a proper inspection with the limited funds at our command. For a time the officers of the department endeavored to visit as many parts of the state as possible, but this procedure, while being of great assistance, did not promote the work as was desired. There was needed a farm-to-farm canvass to ascertain the real conditions. It was then decided to appoint a practical man in each county to conduct the local inspection of the orchards. This system of orchard inspection has been in operation in Maryland for the past eight years. The local inspectors are given a short course free of charge at the college during the winter. The course covers the identification and means of control of the

common injurious insects and diseases and up-to-date methods of orchard management. The inspection is conducted during July, August and September. Each inspector is given an alloted territory by election districts. He is required to plat each orchard on a topographical map of the state as shown by exhibit I. He is also required to make a report of the inspection of each place on the blanks, exhibit II., and directed to leave a card, exhibit III., at each place inspected, which serves to notify the owner or tenant of the inspection, if he should be away at that time. Each card is supposed to be filled out and sent to the office by the grower, who states what he has done or will do in the near future to comply with instructions. I may add that upon the receipt of the reports from the inspectors, we communicate with the growers in regard to the conditions of their orchards.

This system has given much satisfaction in Maryland; our only difficulty is that our funds only permit the inspection of about twenty-five per cent of the state during a season, and we are not able to reinspect this territory within a reasonable time to ascertain the existence of neglected cases and enforce the law, where necessary.

The important aspect of this work that I wish to point out is, *that there is no doubt that the personal contact method of dispensing information is the best means of reaching all growers.* The local inspectors are enabled to have personal interviews with the growers in their own orchards, where they can point out such insects or diseases as may be affecting their trees; suggest proper culture methods and give in a practical manner such information as they need. Moreover, by this system, we are enabled to reach many farmers who may grow a few trees, and orchardists, who may never attend farmers' meetings where such subjects are discussed. Further, the local inspectors can explain the work of the department to the orchardists and show them that our efforts are directed toward helping them in the protection of their trees and in production of good crops, rather than in seeking enforcement of the law.

In my opinion, the extension work of the departments of our colleges and stations, and State departments could well adopt such a plan for disseminating other agricultural information. A visit of a good practical man to many of our farms, spending two or three hours or longer with the owner would be of much greater service to the farmer than many bulletins on the different subjects that may be thrown into the waste-paper basket. The farmer wants practical information and most of them are from "Missouri." The conditions at each place are different, and what would be a good suggestion in farm management for one, may be entirely useless or undesirable for another.

Public Sprayers

In the course of our work in Maryland for the control of the San José scale, we found great need of public spraying outfits in various parts of the state, especially in localities where fruit trees are grown by the farmers for home use only, and around our cities, towns and villages, where a few trees only are grown by suburbanites for the same purpose. Among this class of people there is not sufficient interest at stake, ordinarily, to justify their procuring spraying apparatus with which to properly treat a half dozen or so trees, but they are usually eager to have their trees healthful and willingly employ a public spraying outfit to treat such trees effectively.

It is not an uncommon occurrence to observe every fruit tree growing in some towns or villages badly infested with the scale. In order to aid this class of growers by furnishing means whereby they can have their trees treated and to demonstrate the field for a successful business to the end of inducing private parties to take up the work, our department has conducted public sprayers in different parts of Maryland for the past two years. The past season, twenty-five outfits were operated. A responsible man was secured to superintend each outfit. The spraying was conducted on a basis of cost of operation and not with any desire to make a profit for the department. The past season, the concentrated Lime Sulfur Solutions were used, which greatly facilitated the work.

The venture has been a great success in our state. In each locality where an outfit was operated, there has been more work than could be accomplished prior to the opening of the buds in the spring. This year, two of the outfits continued operations by spraying for the control of the Codling Moth.

Aside from offering immediate relief in saving fruit trees that would otherwise have been killed by the San José scale, the inauguration of this work has accomplished in many instances the principal object for which the work was undertaken. It has shown that there is an opportunity for such a business which will give a reasonable profit where properly conducted. As a result there are many private parties who will conduct public sprayers in Maryland during this coming season; in fact there are some who have done considerable work this fall.

I believe that we, as inspectors and professional men, should aim to develop means whereby our recommendations can be most effectively put into practice. There is no doubt that the operation of public sprayers and the conducting of public spraying demonstrations on the

Alms House farms and in other selected orchards, showing the actual results that can be secured by spraying for the Codling Moth, has accomplished more in stimulating an interest in and popularizing the work of our department in Maryland than any other work that has been undertaken.

The Osage Orange Hedge

I am unable to give actual data as to the general distribution of this hedge plant, but it can be stated, that it is commonly employed as a make-shift fence in the Central, Middle Atlantic and Southern States of our union. Perhaps it is more abundant in Maryland, Delaware, Pennsylvania, Ohio, Kansas and adjoining states than in many others where it is occasionally seen. The plant is indigenous from eastern Kansas south through Arkansas and northeastern Texas, and throughout the prairie regions of the Mississippi basin. As to its occurrence in Maryland, I may state from actual observation that it may be seen in any part of the state but four counties particularly are badly afflicted with this nuisance. In these counties there are undoubtedly far more miles of hedge than county roads. It is rather peculiar that in those counties the fruit interests are far more predominant than in other counties of the state. In many instances, this is practically the only fence on the farm. It thus serves as a division fence between farms, as well as a supposed barrier for farm animals between fields.

The Osage Hedge furnishes an abundant food plant for the San José scale, and as this pest is generally disseminated over the central and eastern parts of the state, it follows that practically every hedge is infested to a greater or less extent; in fact I have not observed an Osage Orange hedge that was not infested with scale. This condition is no doubt true in other states where the two nuisances occur. Unfortunately, the plant is so vigorous that seldom will the scale kill it outright. As hedges offer especial opportunity to the agencies which aid in dissemination of the pest they will serve to infest fruit trees considerable distances from them.

As inspectors, we should be particularly interested in treatment or destruction of the Osage hedge, only as it serves as an important and widespread food plant for the San José scale. However, the hedge may be condemned for other economic reasons, as follows:

First. That seldom is there seen a hedge that will serve as a proper fence. If it serves as a barrier to horses and cattle, it will contain holes, permitting hogs and sheep to pass through, and as a whole may be considered worthless in barring our domestic animals.

Second. While repairing is from time to time necessary, it is seldom practical. This expense added to that of trimming the hedge every year to keep it in a presentable condition, is more than enough to offset the cost of erection of a good wire fence. The hedge should be given one or even two or more trimmings each season. This is an expensive and very disagreeable operation principally on account of the thorns.

Third. The Osage Orange plant is a very vigorous grower, its roots permeate the ground on each side of the hedge for at least ten feet and in many cases greater distances. It thus robs the soil of fertility and moisture that should be accessible to crops planted in the field.

There are, therefore, several vulnerable points of attack, in fact the majority of those who keep Osage hedges recognize it as a general nuisance, but aside from the natural reluctance to lose the first cost of the plants and perhaps many years of expense in maintenance, the expense of grubbing up the hedge and the setting of a new fence is in the majority of cases the only excuse for their existence on so many farms.

In Maryland the department has adopted the policy of allowing the farmers three years in which to rid their property of this nuisance. Thus the hedge bordering on the fields to be cultivated each season can be destroyed. This method will not work a hardship on the owner or tenant, and it is hoped that it will serve to gradually eliminate this important food plant of the San José scale, and otherwise expensive make-shift for a fence from Maryland farms.

It seems to me that a widespread campaign may be waged by the inspectors of the several states in ridding our country of this most troublesome hedge plant.

DISCUSSIONS OF QUESTIONS ON PROGRAM

PRESIDENT: Question Two: "What means can be taken to require the railroad officials to be more strict in demanding certificates when accepting nursery stock for transportation?"

If there is nothing special to be said about this matter, we will pass on, as the railroad officials are very willing to coöperate with the inspector, and I believe have always sent notices of stock received without certificates, or have held the stock, or refused to take it, because it was not accompanied by a certificate.

MR. SURFACE: Notifications of the receipt of foreign stock, however, sometimes do not reach us until the goods have passed through

their freight offices, and the shipments cannot therefore be followed up. These people hold the papers in their office until they have several, instead of forwarding them at once to us. They do not seem to realize the importance of mailing these reports immediately, when shipments pass through their office.

The Secretary of Agriculture of Pennsylvania took this matter up and went to the headquarters of the Pennsylvania Railway Company, and since then we have been notified more promptly.

MR. ATWOOD: We have had something over two thousand reports from transportation companies, and we have had very little complaint to make in regard to delays in mailing the same. We have sixty odd transportation companies with whom we are in correspondence and we agree upon the necessity of prompt reporting, and have in various ways secured the promise of their coöperation, so that the thing is working out very smoothly, for all purposes.

PRESIDENT WASHBURN: Question Four: "Are scale marks to be considered prima facie evidence of infestation?"

MR. GILLETTE: Until this last year we received some little stock that showed signs of this scale; now we are finding a considerable number of shipments containing scale marked trees. In Colorado it is a matter of keeping the insect out of the State.

MR. ATWOOD: We destroy all stock with live scale upon it, and nurserymen are very willing to destroy any trees with scale marks upon them, as their presence is a distinct injury to their business.

We take that stand, because as a rule the nurseryman, as well as the buyer of the stock, will refuse to buy it, if scarred. We never take trees and fix them up for sale. I don't think that has ever been done in the State of New York, and the nurseryman will not handle trees marked with scale, and if received they are returned direct to the shipper. It is necessary for our inspectors sometimes to stand between the nurserymen and the fruit growers.

We all know that trees will show scales, whether they have been treated and fumigated, or not. The nurseryman does not want to arouse the suspicion of his customer, and therefore this is a proposition with which we have nothing to do in our department. The department takes the position that anything with live scales on it must be destroyed.

We have requests received from inspectors in some of the other states, asking how long after a tree was fumigated, it would be in a condition to be sold. How long will a scale retain its freshness and color after its fumigation?

MR. HITCHINS: I have had letters asking the same question, from [illegible], and have replied that we would not take such trees at all.

MR. HEUSTED: I have had an experience which I would like to relate to you. We have had an opportunity to experiment on a shipment coming from another state. The scales were of an olive color and were dry, but we failed to find a single live insect. When one of these trees was examined the following July, however, we discovered a few young lice on it.

PRESIDENT WASHBURN: Question Five: "Should not nurserymen be required to fumigate all buds and cions and by what formula?"

MR. ATWOOD: Some of our nurserymen are obliged to fumigate cions in New York. Cions are fumigated with full strength. I know of one nurseryman who has made a practice of fumigating all of his buds with the full strength formula, allowing fifteen to twenty minutes exposure, and no damage whatever was done.

Now, there is no objection to the nurseryman fumigating his buds, and there is every reason why he should, because the scales are likely to be attached just under the buds.

A man can go into an orchard and get his bud sticks that are infested, and thus introduce the scale into his nursery. I have seen many cases of this kind.

My impression is that fumigation can be successfully used to kill the scale on the buds. Old trees might not be affected by fumigation, but there is some question as to whether a twenty minute exposure during the summer would not result in disaster to growing buds.

PRESIDENT WASHBURN: Question Nine: "What shall be done for the owner after his orchard is inspected?"

MR. SURFACE: We give the orchardist a written report as to what the inspector finds, telling him what pests are found on the trees, a duplicate of which is sent to my office, and at the proper season for treating these pests, we write him again, lest he forget, and tell him that this is the time the pests are to be treated, and also what to do for them. We tell him, also, that if he has a spray-pump, we will send our inspector to his orchard, if he desires, to instruct him in regard to the use of the pump, the only charge made is for the local transportation to and from meals and lodging.

PRESIDENT WASHBURN: Question Twelve: "Shall there be legislation against selling fruits infested with San José scale and the Codling Moth?"

A MEMBER: I might say that such a law might be the best thing for fruit growers, as it would keep infested fruit out of the market.

It would be the very best thing that could be done,—yet they would resent it.

MR. HITCHINGS: At the New England fruit show held in Boston a few weeks ago, some of the prize apples that were awarded the blue ribbons were badly infested with San José Scale, in spite of the fact that the judges were experts on fruit.

I would like to know what to do with infested fruit. I had one person write me, asking if I thought it would hurt him if he ate a San José Scale. I told him I thought he would survive.

MR. GILLETTE: It seems to me that fruit marked with this scale should not be allowed on the market.

PRESIDENT WASHBURN: Question Thirteen: "What are the arguments in favor of inspection and the control of peach yellows and little peach?"

MR. HEUSTED: I suggested this question, as I would like to have some one else's opinion on it.

MR. TAFT: Up to the last year or two, I had seen only one nursery tree which showed signs of disease, but I have seen trees this year which have come from nurseries and were put out in the spring, and showed symptoms before the season was over.

MR. ATWOOD: In our experiments in New York State, we are going to keep watch on this point, as we are all very much interested in it.

Some six years ago we took about ten square miles and attempted to control the peach yellows, and by ordering the trees which were infested taken out annually, the number of diseased trees in that area has gradually grown less.

MR. WILLIAMS: Regarding the question of securing the best pits for the various nurserymen: Our people secured most of their pits as I understand it, from growers in North Carolina.

It is a question as to whether it is a disease in some particular climate or zone, or some particular section. Should a man cease from getting his pits from North Carolina?

MR. GILLETTE: In Colorado the peach yellows has never been known in our peach section, although watched very closely.

MR. WORSHAM: The yellows are liable to develop after the trees are a year old. Professor Phillips has been working with his nurserymen for the past two years, and insisting that they buy their pits from the southern growers, and we have made many inspections of orchards from which pits were taken to be supplied to Georgia growers.

I know Georgia orchardists have supplied a great many pits at Professor Phillips' suggestion.

On the other point, we are not in a position to say.

Professor Scot at one time was of the opinion that the yellows would not spread in the far South, and for a great many years some of the growers carried stock from the East down into Georgia, but we have never found a single case of yellows.

MR. SURFACE: I would like to call attention to an article by G. P. Clinton in the Connecticut Pomological Annual Report for last February, in which he discussed peach yellows, and brings out most important facts. I would suggest that we cite these references, as oftentimes a man is too busy to read every article in the magazines, and that would be the best way to keep in touch with what is going on.

PROFESSOR TAFT: Our experience in Michigan does not give us reason to think that the disease is to any great extent influenced by climatic conditions except that the disease generally seems to be most virulent, or the trees are perhaps more subject to attack, when they have been weakened by a severe winter or other unfavorable climatic conditions. The disease itself is unquestionably of a contagious nature for although peaches are grown quite extensively in thirty or forty of the Michigan counties, yellows was for the first ten years after its appearance in Michigan confined to a single county although the conditions there were not unlike many of the others.

From this county of Berrien, which is in the southwest part of the state, the disease spread gradually to the north and east but in forty years has not advanced more than 100 miles.

Had there been much danger of the spreading of the disease through nursery stock, it would have unquestionably broken out in every county in which peaches are grown but the fact is that it is unknown in fully one half the counties of the state and, at the end of twenty years after it was first noticed, it had not appeared in more than a half dozen counties.

MR. HITCHINGS: In Maine, we have had to do away with the climatic theory maintained in the Connecticut article. We have had for the last few years a great increase of yellows, and the point of the argument is: "Is not this influenced by climatic conditions?"

It has been the feeling among many of our inspectors that the discussion of this article has been inclined to prove that the yellows was due to climatic conditions. The results, however, do not agree with some of the previous work done by Irwin F. Smith.

A MEMBER: Two years ago some fruit trees which were infected with this disease bore premature fruit and this year they bore perfect fruit.

PROFESSOR TAFT: I have seen premature fruit which was rather

red around the pit, which was due to a very hot season or to borers, but that coloration is not characteristic of yellows.

PRESIDENT WASHBURN: Question Fourteen: "Should the sale of premature peaches be prohibited?"

MR. WILLIAMS: This is a question of importance to many growers.

MR. TAFT: Our law requires the destruction of premature fruit, and it has been carried out. It has the effect of securing the proper destruction of infested trees.

Usually owners are not inclined to cut them out, but, with this law, we have been able to have the trees promptly destroyed.

A MEMBER: In some states the growers desire to harvest the crop before destroying the trees.

MR. TAFT: We do not take that into account and so far as we know the disease does not spread during that period of the year, but if these growers were allowed to gather in the fruit and sell it, the trees would not be promptly destroyed. If the fruit cannot be sold, they will cut them out.

PRESIDENT WASHBURN: Question Fifteen: "What is the present status of the Crown Gall on apple? How is such considered in issuing certificates?"

MR. WILLIAMS: In Alabama there is a question whether there should be an allowance for oversight. A great many times the owners of nurseries are not able to determine personally whether all trees are free from Crown Gall.

Now, there was one order delivered, where we found between 2 per cent and 3 per cent of the trees infested with Crown Gall, and according to the law, the nurserymen are required to destroy them.

In some states they allow 2 or 3 per cent for oversight. Every man cannot personally look after his stock.

A MEMBER: If I have been wrong regarding this phase of inspection, you will kindly let me know your opinion.

One of the very largest nurseries noticed a large amount of Gall on raspberries, and I was very certain of the disease. I sent some of them to Washington to confirm my diagnosis, and it proved to be a very bad case of Crown Gall.

I sent them the certificate with the words "Contagious Diseases" left off, so that they have a certificate allowing them to ship stock. It would have caused a row; a very big row. These people are morally convinced that Crown Gall is not injurious.

MR. ENGEL: Destroying the infested trees is the only measure we have taken thus far, although we have to keep the trees from being shipped. Recently a consignment of apple and peach trees came to

Harrisburg which I personally inspected. Fully 15 per cent were rejected outright, and fully 40 per cent of the balance showed marked symptoms of Crown Gall, and were only accepted on condition that the consignee would not sell them, but use them experimentally for his own planting. The balance were accepted and while some of our scientists do not attach much importance to the disease others do, and I would prefer not to plant them myself. I would be glad to know the opinions of the members present as to what they would have done in this case. There is considerable trouble and we must in a measure depend upon the care and honesty of the nurserymen, as there is usually no indication of the disease apparent before digging.

PRESIDENT WASHBURN: I would not, I think, under the circumstances, refuse him a certificate; yet, I would expect him not to send me any more trees of that kind, as all trees I would expect to be free from diseases of any kind, and I would also make him understand that I was giving him the certificate with the understanding that he would reject any trees found with Crown Gall.

MR. WORSHAM: There seems to be a good deal of division along that line, and this Association ought to go on record as to whether we should or should not give certificates in cases of this kind.

MR. GILLETTE: In Colorado the fruit growers despise Crown Gall as much as anything that comes into their orchards. If you come across a stunted tree, you will find if you investigate that it is infested with Crown Gall. Last year one of the leading nurseries in the state shipped more than one hundred thousand trees into another state, and a large percentage of them contained Crown Gall, but we have not received any with Crown Gall, to our knowledge, yet.

A MEMBER: Concerning the statement made by Mr. Engle: I believe I should have allowed him to keep the trees, after destroying the 15 per cent, but I would also have made him promise to plant them himself, and not sell them to his customers.

MR. SUMMERS: My own feeling for several years has been that the Crown Gall was really one of the most serious nursery problems with which the inspector has to deal. There are several distinct aspects of this problem which should be considered. One is the propriety of giving a certificate to a nurseryman on whose grounds Crown Gall is found. I know that our certificates do not always say exactly what they mean. I will say frankly that if I did not give certificates in Iowa to any nurserymen excepting those whose stock is entirely free from Crown Gall I would not issue any certificates. I am speaking here, of course, of general nurserymen who grow apple trees, not of those growing only ornamentals or berry plants. I cannot help

agreeing with what was said by the gentlemen from Colorado. I have been studying this problem for a good many years myself in Iowa.

We have Crown Gall in a good many orchards. The Crown Gall trees do not average in bearing qualities anywhere near the average of the other trees. It is possible for those who are familiar with the effects of this disease to go through an orchard and pick out with a fair degree of certainty the Crown Gall trees. Now the important question is, what are we going to do in controlling this disease? It is quite one thing to say that I, in Iowa, for instance, will require nurserymen to agree to destroy all Crown Gall trees at digging time, and quite another thing to see that this rule is carried out. I have not been entirely consistent in my policy in regard to this. I cannot help regarding it as little more than a mere form to give a certificate and at the same time require an agreement from the nurseryman that he will destroy the Crown Gall trees. The honest nurseryman does not need to have that statement required of him, and the majority of them are honest. The dishonest ones will not respect it. Here is an example of the way this policy works out. One of the oldest and most reliable nurserymen in Iowa was taken ill just before the spring shipping season, with pneumonia. He had been warned that he had more Crown Gall than usual. His foreman had a slight interest in the business, and before we knew it he had sorted out a lot of Crown Gall trees and shipped them to a nurseryman, a dealer, who was going to resell them. I happened to be at that dealer's grounds by accident when the consignment of trees arrived, otherwise I think it probable that they would all have been delivered to customers. This raises the question as to how many Crown Gall trees are being shipped in other places by the employees of nurserymen without the personal knowledge of those nurserymen. The grower above referred to was not personally responsible. He had given proper directions and he was too ill personally to superintend any business. In very many cases large nurserymen are obliged to depend on men who cannot be kept up to the standard the nurserymen would wish. What are we going to do in such a case as this?

Now, I would add in closing, that I think this Crown Gall problem is one which we should do our best to take care of. A nurseryman asks us to inspect and issue a certificate on his stock. We may know that he is doing all that he can to keep this disease out of his nursery, nevertheless, a good deal of Crown Gall is found. He naturally calls upon us for directions as to how he can grow clean stock. If we are to refuse him a certificate because of the presence of any disease it seems to me that we should be able to give him more than a few

vague hypotheses as to the methods by which he can eradicate that disease.

S. J. HUNTER: It seems to me that we have arrived at a place where we may properly ask the question: What part can this Association take in dealing with such cases as the one under consideration? It would seem pertinent to ask, Can this Association standardize the work of the inspectors in the various states? It is generally conceded that the Crown Gall may be found wherever apple stock is grown. The gentleman from Iowa has given proper expression to this phase of the subject. There is some difference of opinion regarding the injurious effect of this crown gall, but the majority, I believe, look upon it as highly detrimental to the life of the host. Crown Gall in the more advanced stages is more readily recognized and therefore does not pass as readily as some of the subjects of quarantine. The issuance of a certificate, with the understanding that the recipient will cull out all the Crown Gall, is a common practice, although by no means a satisfactory one. It seems to me that it is time for us to consider inspection both at the nursery grounds and at the point of destination.

MR. J. L. PHILLIPS: We have done a great deal of work on Crown Gall for five or six years, and we have found, almost invariably, that trees affected by Crown Gall may grow fairly well in the orchard during the first year or two, but will die before many years. They simply rot off and die. The nurserymen have had a great deal of trouble of late years, as some trees in consignments are found to have Crown Gall, while the majority are all right, and we do not feel like discarding them, unless absolutely necessary.

We realize, also, that this is one of the most serious troubles with which the nurseryman has to deal, and we have given a good deal of thought to it, and conducted many experiments.

We noticed that scions from trees affected with Crown Gall would produce diseased trees. Forty to 60 per cent of our experimental trees were affected by this disease where scions were cut from diseased trees.

If you get scions from healthy trees, you will have little or no trouble. We had an opportunity to make observation during the past two years in quite a large number of trees in a new nursery.

The scions came principally from old orchards. A large percentage of the trees are in the nursery at the present time, but of those taken out last fall only about from 6 to 9 per cent were affected with Crown Gall.

Our present understanding of the matter is that scions cut from trees diseased with crown gall will transmit the infection into trees

grown from them and that scions cut from healthy trees will produce healthy trees.

We had an opportunity to observe a very large number of trees during the last 5 or 6 years, and in this nursery, in particular, some 40,000 trees were under our observation. In practically every case where the scions were cut from the tops of diseased trees, they produced Crown Gall.

It looks to me as though, if 50 to 60 per cent of the trees in a nursery are affected with crown gall, the entire lot should be destroyed, but until nurserymen have had a little more time to get their nurseries in condition, this would be rather drastic. These questions, as well as transmission of peach yellows and measures of control in the nursery are discussed in my report now in press.

This concludes the Proceedings of the meeting.

J. B. SYMONS,
Secretary

Scientific Notes

A Typical Name for the Friend Type of Nozzle.—At the meeting of Economic Entomologists in December, 1910, there was more or less confusion when speaking of a comparatively new type of nozzle. As no general name has been decided upon, the maker's name has usually been given this nozzle, such as the Friend, Myers' Power, Deming, etc. It is so distinctly different from the Bordeaux, Vermorel and other types that I would suggest the name Disc. The feature of the nozzle is the disc, which is found at the outlet and regulates the spray.

This type is being used very extensively and is a great improvement over the old nozzles. The name disc describes very simply the main feature and can be generally used in such a way as not to show any partiality to an individual dealer or manufacturer.

Should this suggestion meet with the approval of the Economic Entomologists, might it not be well for all to adopt the same name?

H. L. FROST

Reviews

A Monographic Revision of the Twisted Winged Insects Comprising the Order Strepsiptera Kirby, by W. DWIGHT PIERCE, Smith's Inst. U. S. Nat. Mus. Bull. 66, p. 1–232, 15 pls., 1909.

In this important monograph Mr. Pierce has included practically all that is known concerning the peculiar parasitic insects of the order Strepsiptera. The work contains a detailed account of the systematic relationships of these insects, of their relations to their hymenopterous and homopterous hosts, their effects on these hosts, their taxonomy and geographical distribution, a list of all the known species and a very complete bibliography. He thus presents us with an excellent foundation on which all future students of the group will have to build. To conservative entomologists it will seem that Mr. Pierce has dealt with the taxonomy in a spirit of over-refinement, or preciosity. Accepting Kirby's view that the Strepsiptera constitute an independent order, he seems to feel that he must give this small compact group of highly specialized parasites the status and dignity of one of the larger orders. He therefore divides it into 4 superfamilies and 8 families. He cites 37 genera to include the 109 species; 25, or about two-thirds of the genera, and 40, or somewhat more than one-third of the species being described as new. The desire to fill out an order in this elaborately articulated manner necessarily leads, in the case under discussion, to the use of rather meager characters for superfamily, family, generic and specific distinction, and puts the Strepsiptera out of all proper perspective to the other insect orders. Furthermore, the permanent value of these characters is rendered highly problematical owing to the small amount of material examined, for the Strepsiptera are by no means common in collections. Thus out of the 109 recorded species, only 18 are known from specimens of both sexes, and 10 of these belong to two allied genera. Of the 34 species enumerated in the largest genus, *Stylops*, for example, specimens of 10 have not been examined by the author, 15 are described from single specimens, 4 from two, 3 from three, 1 from four and 1 from five specimens. Some whole genera or even families are based on only one of the sexes. Certainly the meager specific characters utilized by Pierce can have taxonomic value only if it can be shown that they are subject to very little variation. This is impossible, however, with the very limited amount of material now on hand. Whether, under the circumstances, it is better to multiply species and genera and run the risk of sacrificing many of them to a future synonymy, or to proceed very slowly and conservatively, especially when dealing with such a specialized and parasitic group, is a matter on which there may be some difference of opinion. It is certain, however, that the latter method, though it may seem to be more timorous, may have the advantage of not burdening the nomenclature with superfluous names, nor necessitate extensive taxonomic tinkering and readjustment in the future. One of Pierce's reasons for multiplying species is to be found in his assumption that every species of Strepsipteron has its own particular host species. But in *Acroschismus*, of which he has seen more material than of any other genus, this rule breaks down, for *Polistes rubiginosus* is attacked by 4, and *P. texanus* by two species of the parasites, and one of these species is common to both of the wasps. If we accept this postu-

each cage. The plants in two cages were poisoned while those in the other two were not. Four days after the introduction of the weevils on June 29, fully half of them were killed on the poisoned plants, the most of them dying during the first two days. Altho the effect was not as pronounced as where the weevils were feeding upon squares only, it was so encouraging as to lead up to the extensive experiments of 1909.

In 1909 experiments were carried on at four different points on a total of 95 acres with 12 different plots treated and corresponding check plots. The plots were arranged so as to determine the relative value of from 1 to 10 applications and from 1 to 50 pounds per acre according to the number of times applied. The plots were well laid out to determine these points by comparison with the checks and the number of infested squares on a considerable number of plants in each plot was counted nine times at weekly or ten day intervals. In determining the profit the cost of the poison and the labor was deducted from the benefit derived in each plot. The average production of all the cotton poisoned in 12 plots on 46 acres was 673.8 pounds per acre. The average production on 12 similar plots not treated, a total of 49 acres, was 392.6 pounds per acre; thus the average increase in production was 281.2 pounds per acre or 71 per cent. The tables show the profits on each plot in detail and the profits are so uniform and the benefit on the whole area is so evident as to exclude any possibility of the results not being thoroly reliable. The greatest profit per acre was secured by dusting five times, which showed a profit of $23.54 per acre.

Mr. Newell points out that the fall destruction of cotton stalks is necessary even with this treatment. If the poison kills 75 per cent, and the weevils be excessively abundant, the 25 per cent not killed would be more than enough to destroy all the squares. This is evidenced by an experiment at Woodside, La., where there was an unusually heavy infestation in 1908 and no cotton was grown in 1909 except on four acres specially planted for the experiment, upon which the weevils were concentrated, there being 5 to 8 weevils per plant at the first poisoning. Were it not for the poison the crop would have been totally destroyed. As it was the weevils kept coming in until about July 5 and not until three weeks later or after four applications of the poison, were any squares formed. The most successful experiments with the use of dry arsenate of lead were where the stalks had been destroyed the previous fall and the number of hibernating weevils had been so reduced that but a small number escaped the poisoning.

As might be expected the experiments indicated that early varieties show more benefit and it seems probable that the poisoning will be more profitable on the limbless type of cotton than on the spreading sorts, due to the smaller area necessary to dust. Fertilizers also aid in producing earliness with a corresponding greater benefit from the dusting. The applications in the experiments were made at weekly intervals, but the experiments do not show just how often the dusting can be made to best advantage. This needs further work and other points in the practical use of the poison will need to be determined by experiment as the method of application will probably vary with the season and various conditions.

Mr. Ed Neuwirth at West Monroe, La., secured the best results of several planters who made a practical test of the dry arsenate of lead, securing 1461 pounds of seed cotton per acre where it was dusted and 827 pounds per acre on that not dusted, giving an increase of 634 pounds per acre or 76 per cent. He used 6 lbs. of poison per acre, giving four applications. The authors

ture will be devoted to chemistry, the entomological department of the station will have convenient quarters on the second floor, consisting of office, collection room and laboratory with dark room and small insectary connected, giving altogether about 1,400 square feet of floor space. As the corresponding space on the lower floor is to be occupied by the botanical department, all the collections of the station will hereafter be housed in a fire-proof building. In the basement an exhibition room about 20 x 26 feet will be used to display pumps, insecticides and fungicides.

From the March Entomological News we learn of the death of Mr. Henry Ulke of Washington, D. C., on February 18th. Mr. Ulke was 89 years of age and was a well known Coleopterist and portrait-painter.

Professor Charles H. Fernald of the Massachusetts Agricultural College, Amherst, Mass., who has been quite ill since December, is now able to be out again.

Entomological News for March, records the death at San Francisco in February of Mr. George Willis Kirkaldy of Honolulu, H. I. Mr. Kirkaldy was a well known Hemipterist, and the first volume of his catalogue of the Hemiptera of the world has already been published. Mr. Kirkaldy was 35 years of age. He was one of the active members of our association.

Mr. F. A. Johnston, a graduate student at the Massachusetts Agricultural College, has accepted a position with the Bureau of Entomology at Washington, D. C.

Work is progressing rapidly on the new Entomological building of the Massachusetts Agricultural College, Amherst, Mass. This building is now roofed in and is expected to be finished some time next summer. It is large, commodious and fire-proof. We hope to publish a detailed description of the building in a future number of the Journal.

Mr. H. O. Marsh of the branch of Truck-Crop and Stored-Product Insect Investigations of the Bureau of Entomology, U. S. Department of Agriculture, has resumed work at Rocky Ford, Colorado, where he had headquarters last year.

Mr. A. B. Massey, B. S., a graduate of the North Carolina A. & M. College, has been appointed laboratory assistant in Entomology at the Agricultural Experiment Station, Gainesville, Florida, and entered upon his new duties the last week in January.

Prof. E. P. Taylor has resigned his position as Entomologist of the Mountain Grove Experiment Station in Missouri, to take up the horticultural inspection work in Mesa County, Colorado; his post office address is Grand Junction. The county is paying $2,000 a year for this work.

Mr. George P. Weldon, formerly an assistant in the Maryland Agricultural College, and a graduate of the Colorado Agricultural College, is also located in Grand Junction and is acting as field Entomologist for the Agricultural Experiment Station at Fort Collins.

Mr. Donald J. Caffrey, graduate of the Massachusetts Agricultural College and a graduate student of its Entomological department, has accepted a position as assistant to the State Entomologist of Connecticut. Mr. Caffrey entered upon his duties January 17th and will have charge locally of the Gypsy Moth Suppression work at Wallingford.

Mailed April 15, 1910.